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Areas of minor maintenance covered by this manual are--(1) electrical, (2) carpentry, (3) plumbing, (4) painting, and (5) masonry. Each area is defined, tools and equipment for maintenance are listed, and the job procedure is given. The description of electrical work also covers sources of electricity and power transmission. The description of plumbing work includes pipes and pipe fittings. (LD)

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CUSTODIAL TRAINING COURSE

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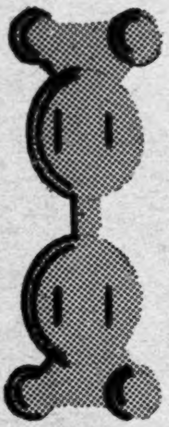
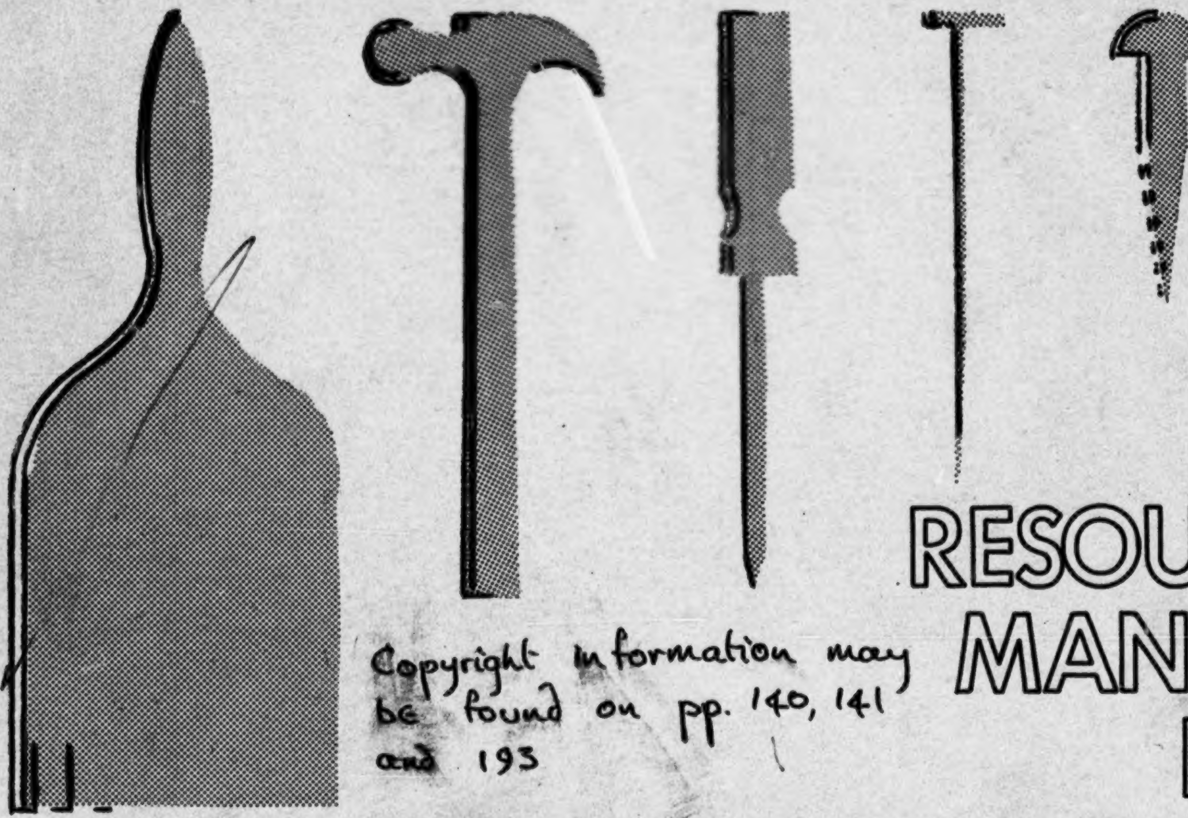


MINOR MAINTENANCE



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A RESOURCE MANUAL FOR CUSTODIANS

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STATE DEPARTMENT OF EDUCATION
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TALLAHASSEE, FLORIDA

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Appreciation is extended to the Florida School Plant Management Association and the custodial training committee for their assistance. The following publications have rendered an incalculable service in providing an excellent source of reference material.

A PRACTICAL MANUAL ON PENCIL SHARPENERS FOR CUSTODIANS	Hunt Manufacturing Co.
BASIC ELECTRICAL AND ELECTRONIC PRINCIPLES Suffern	McGraw-Hill Book Company
BASIC ELECTRICITY Howard W. Sams and Company, Inc.	The Bobbs-Merrill Company, Inc.
CONCRETE BLOCK CONSTRUCTION FOR HOME AND FARM Dalzell & Townsend	American Technical Society
ELECTRICITY Gerrish	Goodheart-Willcox Co.
EXPLORATORY ELECTRICITY Arnold and Schank	McKnight & McKnight Publishing Company
FUNDAMENTALS OF APPLIED ELECTRICITY Jones	The Bruce Publishing Company
FUNDAMENTALS OF ELECTRICITY Calvin C. Bishop	Chilton Company

INDUSTRIAL-ARTS ELECTRICITY	Lush & Engle	Charles A. Bennett Co., Inc.
MASONRY SIMPLIFIED	Dalzell & Townsend	American Technical Society
MECHANICS ILLUSTRATED PLUMBING AND HEATING GUIDE	Paul Villiard	Fawcett Publications Incorporated
MODERN GENERAL SHOP	Brown, Gerrish, Wagner and Boyd	Goodheart-Willcox Co.
POPULAR SCIENCE		Popular Science Publishing Co., Inc.
SCHOOL BUSINESS MANAGEMENT HANDBOOK	The State Education Department	The University of the State of New York
WOODWORKING FOR INDUSTRY	Feirer	Charles A. Bennett Co., Inc.

WHAT PAINT TO USE...AND WHERE from NEW PAINTS GALORE

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INTRODUCTION

On the surface it would appear rather simple to arrive at a common understanding concerning the duties of the custodian, and to compile a list of duties for which he is paid to perform. Upon investigation, however, one discovers complexities in the areas of administrative structure, philosophy, nomenclature, civil service, union restrictions, size of school system, tax problems resulting in money available, the labor market and the socio-economic structure of the community.

The large, highly diversified systems employ specialists in almost every conceivable area of cleaning and maintaining a school plant. This leads to a natural breakdown of the duties of each person under a specific classification. The large system also is subject to Union demands and Civil Service restrictions. Each person in such a system is classified as to title, salary, hours, duties, etc. For example, custodial positions in one large system under Civil Service are classified as follows.

1. Competitive Class
   - Building Maintenance Mechanic
   - Custodian
   - Custodian-Bus Driver
   - Head Custodian
   - Stationary Engineer
   - Steam Fireman
   - Superintendent of Buildings & Grounds
2. Non-competitive Class
   - Auto Mechanic

Bus Driver Cleaner

Bus Driver Laborer

Carpenter

Electrician

General Mechanic

Head Maintenance Man

Painter

Plumber

3. Exempt Class

Cleaner

Groundsman

Laborer

School Caretaker

Watchman

The above list of employees have as their administrative leaders an equally specialized group of people responsible for administering the program. Compare this to a small county or system where there is only one or possibly two classifications as follows:

1. Janitor
2. Mechanic

The Administrative structure to administer this program is usually the School Superintendent and maybe one other school official such as the purchasing Agent or Director of Special Services.

Bear in mind, both systems as illustrated have identical problems. Each have school buildings, requiring cleaning, painting, plumbing, electrical and mechanical repairs as well as grounds to maintain. Each has school buses, heating plants, mowers, trucks, etc. Each has the same responsibility to provide educational facilities, and to protect the investment.

It can be said that both systems meet their responsibilities, however the level or degree of satisfaction to health departments, building inspectors, tax payers, children of the community, and local, state, and federal standards may be questionable.

This is one reason for having schools ranging from excellent to unsatisfactory. The comparison of these two systems is similar to comparing the General Practioners to the highly diversified specialists in the various phases of medical treatment.

It is not intended to create the impression that the specialized system is superior to the one or two man operation, provided the men are qualified in the many overlapping areas for which they are employed.

If we are to come to a common ground on which to discuss MINOR MAINTENANCE we have to decide first where custodial duties stop and maintenance duties begin.

Custodial duties are generally classified as those day to day services essential to the safety, comfort and well-being of those who attend or occupy the school plant.

Maintenance duties consists of those services and procedures concerned with preserving, protecting and keeping buildings and grounds and equipment in proper repair, as near as possible to the original condition.

One can readily see there is an overlapping of these two services. For example: a window is broken impairing the safety and comfort of the occupants; the repair of this item is a maintenance task although by definition the custodian is responsible for the safety and comfort of the persons in the building.

Who takes care of this "immediate" problem?

For conjecture, let us consider the following incident.

A common brick from the school ornamental fence is dislodged and thrown through a classroom window breating the light fixture and striking a wall. In the request to obtain repairs, an electrician is needed to repair the light fixture, a mason to replace the brick, a glazer to replace the window, a plasterer to repair the wall, a painter to restore the paint, and a custodian to clean up the debris. To further complicate the issue the brick could have landed in the sink and broken the fixture requiring a plumber.

Is this far fetched? One need only to look at the vandalism reports from many school systems to see how many trades are involved in the repair of one act of vandalism or even a small unprovoked accident.

In a small school system either the school custodian would repair the entire damage or an outside contractor would be called, depending on the capability of the custodian (janitor, cleaner, caretaker, etc.)

It appears that MINOR MAINTENANCE can be construed as that area falling somewhere between cleaning and repairing. (In most cases this is an immediate emergency area which needs attention so as not to affect the safety and comfort of the occupants as well as the preservation of the physical plant to avoid expensive repair thereby exhibiting good economy practices.)

Do not interpret this emergency area with emergency repairs requiring the services of a specialist in a particular field or major construction.

The following is a comprehensive list of MINOR MAINTENANCE duties that the custodian may be called upon to perform. Custodians in some areas may only be responsible for one or two of these duties.

List of Minor Repairs

1. Replacing broken window glass.
2. Tightening screws and bolts in furniture.
3. Attaching desks to floors.
4. Adjusting winter shade rollers.
5. Attaching shades to rollers.
6. Replacing window cords.
7. Replacing electric fuse plugs.
8. Replacing electric light switches.
9. Replacing electric light sockets and fixtures.
10. Tightening loose door knobs.
11. Replacing door knobs.
12. Adjusting door checks.
13. Removing or attaching door checks.
14. Adjusting "adjustable" desks to pupils.
15. Replacing washers in valves.
16. Pack valves in heating apparatus pumps.
17. Regulating flow of drinking fountains.
18. Replacing or adjusting balls in toilet flush tanks.
19. Cleaning traps.
20. Replacing radiator steam traps.
21. Replace water glasses.
22. General painting.
23. Varnishing woodwork.
24. Repair furniture.
25. Refinishing furniture.
26. Repairing playground equipment.
27. Sharpening tools.
28. Repair tools.
29. Cleaning a clogged toilet or drain.
30. Fastening loose trim or molding.
31. Repairing pencil sharpeners.
32. Repair fans.
33. Repair and replace transom rods.

34. Paint fire escapes.
35. Repair of hardware.
36. Repair of hand rails.
37. Others as assigned.

The idealistic approach to this much needed area of instruction would be a tailor-made course for each system. The realistic approach is a course designed to cover a cross-section of the problems which may be encountered to broaden the "custodian's" background so that he may either repair the defect or know how to intelligently evaluate the defect, order parts for, and notify the proper tradesman.

The ultimate objective of this unit is to prevent undesirable "patchwork" service and to eliminate the "trial and error" system of a man evaluating his own potential, while on-the-job, thereby affecting good economy of labor.

CHAPTER I
ELECTRICAL

DEFINITIONS - ELECTRICAL

ALIVE - Carrying a voltage or current. (LIVE)

ALTERNATING CURRENT - An electric current that reverses its direction of flow at regular intervals.

AMBER - A yellowish resinous substance that can be used to produce static electricity by friction.

AMERICAN WIRE GAUGE - The gauge is used for designating the sizes of solid copper wires used in United States. Formerly called Brown and Sharpe (Best gauge).

AMMETER - The instrument that indicates the rate of flow of electricity through a circuit.

AMPERE - The practical unit that indicates the rate of flow of electricity through a circuit.

AMPERE-HOUR - The quantity of electricity delivered by a current of one ampere flowing for one hour. Used in rating storage batteries.

ARTIFICIAL MAGNET - A manufactured permanent magnet, as distinguished from natural magnets.

ATOM - The smallest particle or unit of matter that can be chemically united.

AUXILIARY CIRCUIT - Another circuit besides the main circuit; often a control circuit.

AUXILIARY SWITCH - A switch operated or controlled by the action of another circuit.

BX - A term often used for flexible armored cable.

BAKELITE - A moulded insulating material.

BAYONET SOCKET - A lamp socket that has two lengthwise slots in the sides of socket and at the bottom the slots make a right angle turn. The lamp base has two pins in it that slide in the slots in the socket. The lamp is held in the socket by being given a slight turn when the pins reach the bottom of the slots.

BRAIDED WIRE - A conductor composed of a number of small wires twisted or braided together.

BRANCH CIRCUIT - That part of the wiring system between the final set of fuses protecting it and the place where the lighting fixtures or drop cords are attached.

BROWN AND SHARPE GAUGE - The gauge used in United States for copper wires. Same as American wire gauge.

BURN OUT - Damage to electric machine or conductors caused by a heavy flow of current due to short circuit or grounds.

B-X CABLE - Trade name for armored cable made by General Electric Co. commonly used to refer to armored cable.

CABLE - A conductor composed of a number of wires twisted together.

CABLE BOX - A box which protects the connections or splices joining cables of one circuit to another.

CABLE CLAMP - A clamp used to fasten cables to their supports.

CAPACITY - Ability to hold or carry an electric charge. The unit of capacity is farad or microfarads.

CARTRIDGE FUSE - A fuse inclosed in an insulating tube in order to confine the arc or vapor when the fuse blows.

CELL - A jar or container holding the plates and electrolyte of one unit of a storage or primary battery.

CHARGE - That quantity of static electricity stored between the plates of a condenser.

CIRCUIT - The path taken by an electrical current in flowing through a conductor from one terminal of the source of supply to the other.

CIRCUIT BREAKER - A device used to open a circuit automatically.

CLOCKWISE ROTATION - Turning in the same direction as the hands of a clock; right-handed rotation.

CLOSED CIRCUIT - A complete electric circuit through which current will flow when voltage is applied.

CONDENSER - Two conductors separated by an insulating material that is capable of holding an electrical charge.

CONDUCTANCE - The ease with which a conductor carries an electric current; it is the opposite of resistance. The unit of conductance is the mho (word "ohm" spelled backward).

CONDUCTOR - A wire or path through which a current of electricity flows; that which carries a current of electricity.

CONDUIT - A pipe or tube, made of metal or other material, in which electrical conductors or wires are placed.

CONDUIT BOX - An iron or steel box located between the ends of the conduit where the wires or cables are spliced.

CONDUIT BUSHING - A short threaded sleeve fastened to the end of the conduit inside the outlet box. Inside of sleeve is rounded out on one end to prevent injury to the wires.

CONDUIT COUPLING - A short metal tube threaded on the inside and used to fasten two pieces of conduit end to end.

CONDUIT ELBOW - A short piece of conduit bent to an angle, usually to 45 or 90 degrees.

CONDUIT RIGID - A mild steel tubing used to inclose electric light and power wires.

CONDUIT ROD - A short rod which is coupled to other rods and pushed through the large conduit to remove obstructions and pull a cable into the conduit.

CONDUIT WIRING - Electric light wires placed inside conduit.

CONTACT - A place where a circuit is completed by a metallic point being pressed against a conductor. When the pressure is removed, the circuit is opened and flow of current stopped.

CONTACT SPARKING - The spark or arc formed at the contact points when a circuit carrying current is opened.

COPPER - A metal used for electrical conductors because it has less resistance than any other metal except silver.

CORD - Two insulated flexible wires or cables twisted or held together with a covering of rubber, tape, or braid.

COTTON-COVERED WIRE - A wire covered with a layer of thin cotton threads wound spirally around it.

COTTON-ENAMELED WIRE - An enameled insulated wire covered with a layer of cotton threads.

COTTON-SLEEVING - A woven cotton sleeve or tube slipped over wires to insulate them.

COULOMB - The quantity of electricity passing through a circuit. It is equal to amperes times seconds. An ampere hour = 3600 coulombs.

CURRENT - The flow of electricity through a circuit.

CURRENT STRENGTH - The flow of current in amperes.

CYCLE - The flow of alternating current first in one direction and then in the opposite direction in one cycle. This occurs 60 times every second in a 60-cycle circuit.

D.C. - Used as an abbreviation for "direct current", or "double contact."

D.P. - Used as an abbreviation for "double pole."

D.P.S. - Used as an abbreviation for "double pole snap switch."

D.P.S.T. - Used as an abbreviation for "double pole single throw."

D.P.D.T. -Used as an abbreviation for "double pole double throw."

DEAD WIRE - A wire in which there is no electric current or voltage.

DE-ENERGIZE - To stop current from flowing in a circuit or an electrical part.

DIELECTRIC - Insulation between conductors of opposite polarity; term generally used only when induction may take place through it.

DIELECTRIC STRENGTH - Ability of a dielectric to withstand electrical pressure before breaking down. This is measured in volts necessary to puncture the dielectric.

DIFFERENCE OF POTENTIAL - Difference in voltage between two conductors or two points along one conductor carrying an electric current.

DIRECT CURRENT - Electric current flowing over a conductor in one direction only. Abbreviation - D.C.

DISCONNECT - To remove an electrical device from a circuit, or to unfasten a wire, making part or all of the circuit inoperative. The word is particularly applied to the act of severing a telephone connection to permit repairs.

DISTRIBUTION BOX - Small metal box in a conduit installation, giving accessibility for connecting branch circuits.

DISTRIBUTION SYSTEM - The whole circuit and all of its branches which supply electricity to consumers.

DOUBLE-POLE - A term designating two contacts or connections on a device, for instance, a double-pole knife switch. See D.P.

DOUBLE -THROW SWITCH - Switch which can be operated by making contact with two circuits. Abbreviation D.T.

DROP OF POTENTIAL OR VOLTAGE - Decrease of voltage at points along a circuit, caused by resistance.

DUPLEX CABLE - Cable consisting of two wires insulated from each other and having a common insulation covering both.

DYNAMIC ELECTRICITY - Electricity in motion as distinguished from static electricity.

E - Symbol for volts.

EARTH - Synonym of "ground," meaning the grounded side of an electrical circuit or machine.

ELBOW - Hollow fixture for connecting two lengths of conduit at an angle, usually fitted with a removable cap to facilitate drawing the wires through one conduit and then inserting them in the other one.

ELECTRIC CIRCUIT - Path through which an electric current flows.

ELECTRIC POTENTIAL - Pressure or voltage of electricity.

ELECTRIC POWER PLANT - Installation consisting of a prime mover driving a generator to produce electricity.

ELECTRIC UNITS - Standards of measurement of electrical properties; for instance, ampere, volt, ohm, farad, henry, etc.

ELECTRICAL CODES - Rules and regulations for the installation and operation of electrical devices and currents.

ELECTRICITY - Invisible energy capable of moving 186,000 miles per second. Electricity is really not capable of being defined exactly, with present knowledge.

ELECTROCHEMICAL - Pertaining to the interaction of certain chemicals and electricity, the production of electricity by chemical changes, the effect of electricity upon chemicals, etc.

ELECTROMAGNET - Soft iron core having a coil wound around it through which an electric current is passed. The core is magnetized while the current flows, but is demagnetized when the current stops.

ELECTROMAGNETIC ATTRACTION - Repulsion between like poles of an electromagnet.

ELECTROMAGNETISM - Science dealing with electricity and magnetism and their interaction.

ELECTRON - Electrical particle, of negative polarity.

ELECTRON THEORY - Theory that all matter consists of atoms which in turn comprise a positive nucleus and number of negative electrons, which may be detached from the atom under certain conditions, leaving it positively charged.

ELECTROTHERMAL - Pertaining to the heating effect of electric currents produced by heat, as in thermo-couple.

ENAMELED WIRE - Wire having a coating or enamel baked on, which serves as insulation.

ENCLOSED FUSE - Fuse inside of a glass tube to prevent ignition of gas or dust.

EXTENSION - Length of cable or lampcord fitted with a plug and a socket to extend a lamp or other electric device further than the original point.

FARAD - Unit for measuring electrical capacity. It is the capacity of a condenser which will give a pressure of one volt when a one ampere current flows into it for one second.

FAULT - Trouble in an electrical circuit.

FEEDER - Line supplying all the branch circuits with the main supply of current.

FEEDER BOX - Box into which the feeder is run for connection to a branch circuit.

FIBRE CONDUIT - Insulating tubing made of moulded fibre.

FIXTURE - Device for holding electric lamps, which is wired inside and is securely attached to the wall or ceiling.

FLEXIBLE CABLE - Cable consisting of insulated, stranded or woven conductors.

FLEXIBLE CONDUIT - Non-rigid conduit made of fabric or metal strip wound spirally.

FLEXIBLE CORD - Insulated conductor consisting of stranded wire.

FLOW - Passage of a current through a conductor.

FRICTION TAPE - Tape coated with black adhesive compound, used as insulation on wire joints, etc.

FUSE - Safety device to prevent overloading a current. It consists of a short length of conduction metal which melts at a certain heat and thereby breaks the circuit.

FUSE CUTOUT - Fuse which, when melted, cuts out the circuit.

FUSE PLUG - Fuse mounted in a screw plug, which is screwed in the fuse block like a lamp in a socket.

FUSE WIRE - Wire made of an alloy which melts at a comparatively low temperature.

GANG SWITCH - Two or more switches installed in one box or one holder.

GENERATOR - Machine that produces electricity.

GENERATOR OUTPUT - Power delivered by a generator, measured in watts or kilowatts.

GREENFIELD CONDUCTOR - Flexible cable having a spirally wound metal covering.

GROUND CIRCUIT - Part of an electric circuit in which the ground serves as a path for the current.

GROUND CLAMP - Clamp on a pipe or other metal conductor connected to the ground for attaching a conductor of an electrical circuit.

GROUNDED NEUTRAL WIRE - The neutral wire of a 3-way distribution system which is connected to the ground.

HOT CONDUCTOR - A term used to refer to a conductor or wire which is carrying a current or voltage.

I - An abbreviation for amperes of current.

INCOMPLETE CIRCUIT - An open circuit.

INDUCTANCE - The ability of an electric circuit to produce induction within itself.

INSULATE - To place insulation around conductors or conducting parts of a device or object.

INSULATING VARNISH - A special prepared varnish which has good insulating property and is used to cover the coils and windings on electric machines and improve the insulation.

JOINT - The uniting of two conductors by means of solder.

JUMP SPARK - A spark that passes between two terminals or across a gap. It is produced by high voltage.

JUMPER - A temporary connection made around part of a circuit.

JUNCTION BOX - A box in a street distribution system where one main is connected to another main; also a box where a circuit is connected to a main.

KILOWATT - One thousand watts.

KILOWATT-HOUR - One thousand watt-hours.

KNIFE-SWITCH - A switch that has a thin blade that makes contact between two flat surfaces to complete the circuit.

LAMP CIRCUIT - A branch circuit supplying current to lamps only, and not to motors.

LAMP CORD - Two flexible stranded insulated wires twisted together and used to carry the current from the outlet box to the lamp socket.

LEADING-IN WIRES - Wires used to carry current from the outside of buildings to the inside of buildings.

LEAK - A loss of charge in a storage battery where current can flow through a circuit, or to ground, due to defective insulation.

LIGHT LOAD - A load that is less than the normal load on the circuit.

LIGHTNING ARRESTER - A device that allows the lightning to pass to the ground thus protecting electrical machines.

LINE DROP - The loss in voltage in the conductors of a circuit due to their resistance.

LIVE - A circuit carrying a current or having a voltage on it.

LOAD - The work required to be done by a machine. The current flowing through a circuit.

LOOSE CONTACT - A poor connection that does not make proper contact.

MAGNET - A body that will attract iron or steel.

MAGNETIC COIL - The winding of an electromagnet.

MAGNET CORE - The iron in the center of the electromagnet.

MAGNETIC FIELD - The magnetic lines of force that pass in the space around a magnet.

MAGNETIC POLE - The ends of the magnet where the magnetism enters or leaves the magnet.

MAIN - The circuit from which all other smaller circuits are taken.

MAINTENANCE - Repairing and keeping in working order.

METAL CONDUIT - Iron or steel pipe in which electric wires and cables are installed.

METAL MOULDING - A metal tube or pipe, installed on the ceiling or walls of a building, in which electric wires are installed.

MOTOR - A machine that changes electrical energy into mechanical power.

MOTOR-GENERATOR - An electric motor driving a generator changing alternating to direct current or the reverse.

MULTIPLE CIRCUIT - A circuit in which the devices are connected in parallel with each other.

MULTIPLE SERIES - A parallel connection of two or more series circuits.

N.E.C. - Abbreviation for National Electric Code; often called Underwriter's Code.

N.E.L.A. - Abbreviation for National Electric Light Association.

N.F.P.A. - Abbreviation for National Fire Prevention Association.

NEGATIVE - The point towards which current flows in an external electrical circuit; opposite to positive.

NEGATIVE CHARGE - Having a charge of negative electricity.

NEGATIVE CONDUCTOR - The conductor that returns the current to the source after it has passed through a device and has been used.

NEUTRAL - Not positive or negative although it may act as positive to one circuit and negative to another.

NEUTRAL CONDUCTOR - A middle conductor of a three-wire direct-current or single-phase circuit.

OHM - The unit used to express the resistance of a conductor to the flow of electric current through it.

OHM'S LAW - A rule that gives the relation between current, voltage, and resistance of an electric circuit. The voltage (E) is equal to the current (I) in amperes times resistance (R) in ohms. The current (I) equals the voltage (E) divided by the resistance (R) of the circuit. The resistance (R) is equal to the voltage (E) divided by the current (I).

OPEN CIRCUIT - A break in a circuit. Not having a complete path or circuit.

OPEN WIRING - Electric wires fastened to surfaces by the use of porcelain knobs. Wiring that is not concealed.

OUTLET - A place where electrical wires are exposed so that one can be joined to the other.

OUTLET BOX - An iron box placed at the end of conduit where electric wires are joined to one another and to the fixtures.

POLE - The positive and negative terminal of an electric circuit. The ends of a magnet.

POSITIVE - The point in a circuit from which the current flows; opposite to negative.

POSITIVE TERMINAL - The terminal of a battery or generator from which the current flows to the external circuit.

POTENTIAL - The pressure, voltage, or electromotive force that forces the current through a circuit.

POWER - The rate of doing work. In direct current circuits it is equal to E x I. The electrical unit is the watt.

RACEWAYS - Metal molding or conduit that has a thinner wall than standard rigid conduit used in exposed wiring.

RATING - The capacity or limit of load of an electrical machine expressed in horsepower, watts, volts, amperes, etc.

RECEPTACLE - A device placed in an outlet box to which the wires in the conduit are fastened, enabling quick electrical connection to be made by pushing an attachment plug into it.

RESISTANCE - That property of a substance which causes it to oppose the flow of electricity through it.

RUBBER-COVERED WIRE - Wires covered with an insulation of rubber.

RUBBER TAPE - An adhesive elastic tape made from a rubber compound.

SAFE CARRYING CAPACITY - The maximum current a conductor will carry without overheating.

SAFETY CATCH OR FUSE - A device that opens the circuit when it becomes too hot; often placed in base of appliances for heating liquids.

SAFETY SWITCH - A knife switch inclosed in a metal box and opened and closed by a handle on the outside.

SERIES - Connected one after another so the same current will flow through each one.

SERIES CIRCUIT - A circuit in which the same current flows through all the devices.

SERVICE ENTRANCE - The place where the service wires are run into a building.

SERVICE-WIRES - The wires that connect the wiring in a building to the outside supply wires.

SHEATH - The outside covering which protects a wire or cable from injury.

SHORT - A contraction for short circuit.

SHORT CIRCUIT - An accidental connection of low resistance joining two sides of a circuit, through which nearly all the current will flow.

SINGLE-POLE SWITCH - A switch that opens and closes only one side of a circuit.

SINGLE-WIRE CIRCUIT - A circuit using one wire for one side and ground for the other side or return conductor.

SOLID WIRE - A conductor of one piece instead of being composed of a number of smaller wires.

SOUTH POLE - The end of a magnet at which the lines of force enter.

SPLICE - The joining of the ends of two wires or cables together.

STATIC ELECTRICITY - Electricity at rest as distinguished from electric current, which is electricity in motion.

STATOR - The stationary part of an induction motor on which the field windsings are placed.

STEADY CURRENT - A direct current whose voltage does not change or vary.

STEP-DOWN - Reducing from a higher to a lower value.

STEP-UP - Increasing, or changing from a low to a higher value.

STORAGE BATTERY - A number of storage cells connected together to give the desired current and voltage and placed in one case.

STORAGE CELL - Two metal plates or sets of plates immersed in an electrolyte in which electric current can be passed into the cell and changed again into chemical energy and then afterwards changed again into electrical energy.

STRANDED WIRES - Wires or cables composed of a number of smaller wires twisted or braided together.

STRENGTH OF CURRENT - The number of amperes flowing in the circuit.

SWITCH - A device for closing, opening, or changing the connections of a circuit.

SWITCH PLATE - A small plate placed on the plastered wall to cover a push button tumber switch.

T-SPLICE - A connection joining the end of one wire to the middle of another one.

TERMINAL - A connecting device placed at the end of a wire, appliance, machine, etc., to enable a connection to be made to it.

TERMINAL LUG - A lug soldered to the end of a cable so it can be bolted to another terminal.

TEST CLIP - A spring clip fastened to the end of a wire used to make connections quickly and testing circuits or devices.

TEST LAMP - An incandescent lamp bulb and socket connected in a circuit temporarily when making tests.

THREE-WAY SWITCHES - A switch with three terminals by which a circuit can be completed through any one of two paths.

TINNED WIRE - Wire covered with a coating of tin or solder.

TRANSFORMER - A device used to change alternating current from one voltage to another. It consists of two electrical circuits joined together by a magnetic circuit formed in an iron core.

TRANSFORMER RATIO - The ratio of the primary to the secondary voltages.

TRANSMISSION LINE - High voltage conductors used to carry electrical power from one place to another.

TWO-WIRE CIRCUIT - A circuit using two wires.

UNDERGROUND CABLE - A cable insulated to withstand water and electrolysis and placed in underground conduit.

UNDERWRITERS' CODE - The National Electric Code.

VOLT - A unit of electrical pressure or electromotive force.

VOLTAGE DROP - The difference in pressure between two points in a circuit caused by the resistance opposing the flow of current.

VOLTMETER - An instrument that shows the pressure or voltage of a circuit.

WALL BOX - A metal box for switches, fuses, etc., placed in the wall.

WALL SOCKET - An electric outlet placed in the wall so that conductors can be connected to it by means of a plug.

WATT - The unit of electric power.

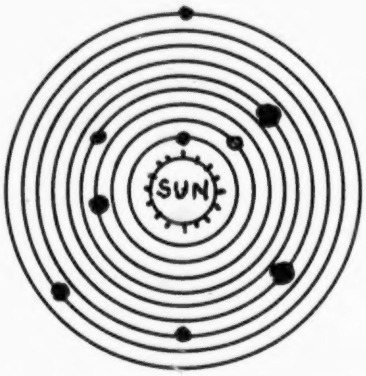
WATT-HOUR - The use of a watt of power for an hour.

WESTERN UNION SPLICE - A method of uniting two wires together by wrapping each one about the other.

CHAPTER I

A. UNDERSTANDING ELECTRICITY

Electricity is a potential force always available if one knows how to release it and control it. In order to understand electricity, we must know something about the "nature of things". Matter -- all things may be considered matter, earth, water, wood, rock, air, etc., the list is inexhaustable. All matter and material is composed of small solar-like systems, i.e., the sun, planets, moon and other celestial bodies. Our solar system revolves around the sun (star).



SOLAR SYSTEM

FIG. 1

If we examine a piece of wood for example, we find that it is composed of atoms. Each atom is a solar system. At the center of each atom is a nucleus (sun) surrounded by electrons (planets). The electrons revolve around the nucleus as the planets do the sun. Our solar system has nine known planets. Some atoms have more electrons than nine and some have less. Science has been able to discover or distinguish 103 different atoms. If a piece of matter has only one kind of atom it is an "element". If it contains more than one kind of atom it is a compound. Everything we experience whether it be liquid, gas or solid, is either an element or a compound. Different kinds of atoms joined together make different substances in physical appearance and in feel, thus we have rocks, cotton, water, wood, metal, etc. This atomic THEORY is a simple statement compiled after many many years of exhausting experiments by now famous people.

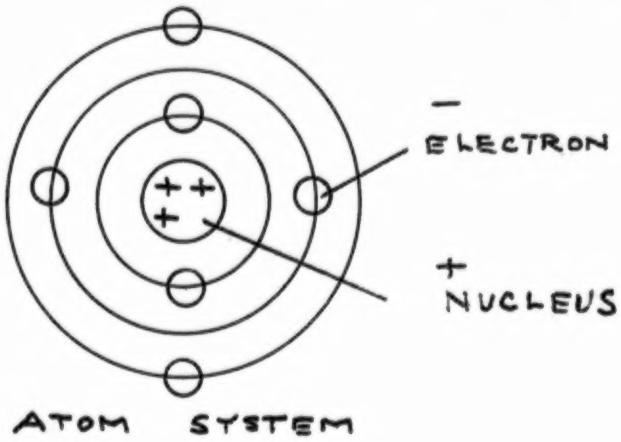


FIG 2

What has all this to do with electricity? Certain phenomena that has been occuring for billions, yes billions, of years has aroused the curiosity of man.

Lightning was probably the first and still is the phenomenon that has yet to see the day when it will be fully utilized.

The ancient Greeks have been credited with the term "electron" or "electricity". They found that by rubbing amber, a fossil resin able to be polished, with a cloth it would "attract" small pieces of light material like straw, leaves, paper, etc. The Greek word for amber is ELEKTRON, thus electricity.

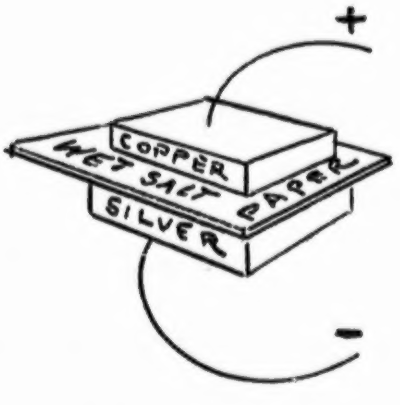


FIG. 3

In the 17th Centuny (1600's) experiments began to take place. One experiment was by two men named Galvani and Volta. They found that by separating two unlike metals (silver, copper) by salt soaked paper, a potential was developed. The potential was not measured by meters as we know today. They used frogs legs -- they twitched when touched by this potential. Today we have GALVANOMETERS named for Galvani. We speak of VOLTS named for Volta. In our discussion of electricity to follow we will use terms named after other famous men who contributed to the unravelling of the mystery of electricity.

James Watt (1736)

George Ohm (1787)

Andri Ampere (1777)

Michael Faraday (1791)

Charles Coulomb (1736)

To begin with, we said electricity is potential. Webster defines potential as a power or force that can be released or developed. Going back to the Atomic Solar System it was discovered that the electrons have what is called a "negative charge" and the core or nucleus is a positive charge. The electrons are attracted by the positive charge and are held in ORBIT by equalization or by the proper balance, similar to a scale.

Some of the electrons in the outer ring of the atom are said to be less stable and not attracted tightly to the nucleus therefore, if they were prodded a bit they would leave their orbit and begin to "fly off" or move. If these free electrons are given direction and if the force moving them (volts) is strong enough and continuous then we get a flow of electrons, i.e., current flow or (amperes). If the conductor through which these electrons are flowing is small in diameter they will encounter resistance (ohms). This resistance causes friction and friction develops heat. Thus a small diameter wire conveying a rapid movement of electrons pushed by a continuous force will cause the wire to get

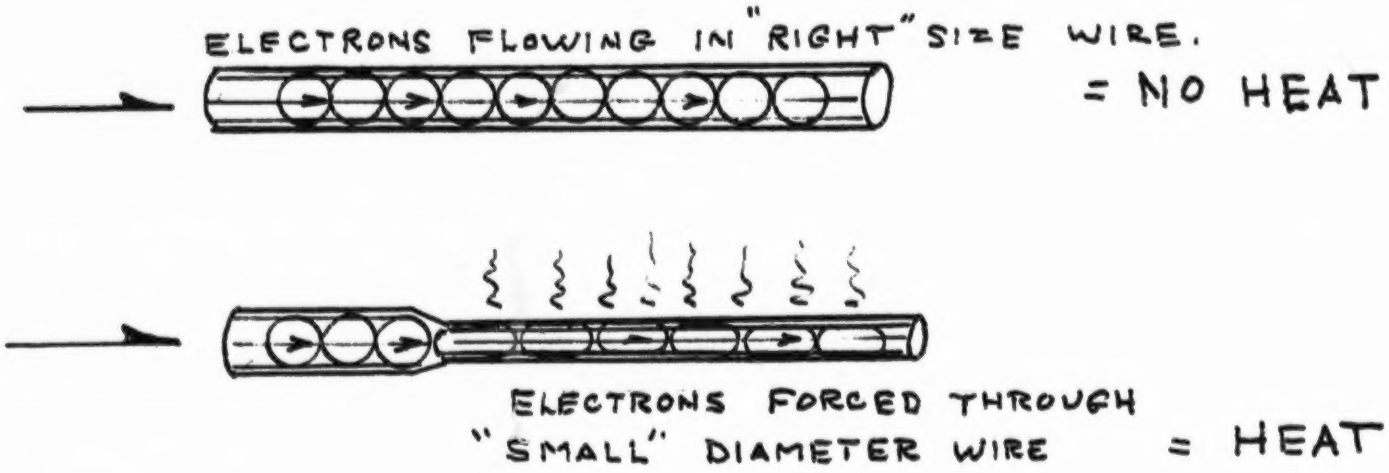

ELECTRONS FLOWING IN "RIGHT" SIZE WIRE.
= NO HEAT
ELECTRONS FORCED THROUGH "SMALL" DIAMETER WIRE
= HEAT

FIG. 4

very warm and possibly even glow such as a toaster wire or an electric heater.

Some substances have a great many free electrons ready to be moved, these are called good conductors of electricity. Copper and silver are examples of good conductors.

Other substances have strongly attached electrons and are considered poor conductors. Glass, rubber, cotton, and air are examples of poor conductors. They are used to wrap a copper wire so that no other substance or good conductor will come in contact with the copper wire and offer the electrons another path to move on.

Some electrons can be rubbed off a substance by friction as the ancient Greeks did with "amber". When this is done the substance is

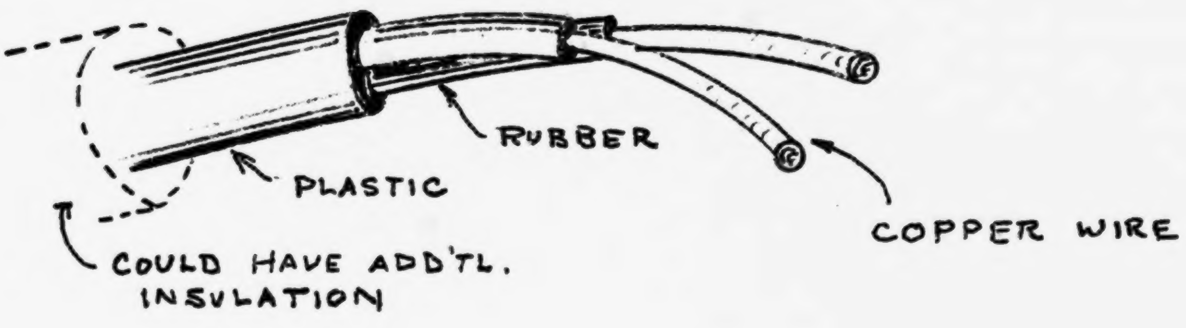

RUBBER
PLASTIC
COPPER WIRE
COULD HAVE ADD'TL. INSULATION

FIG. 5

no longer what we call neutral. If it looses electrons the substance becomes (+) or positively charged and the substance that picked up the electrons becomes (-) negatively charged---this creates a potential (a force ready to be dislodged) because the substance wants to return to neutral by getting back its electrons. Lightning is a sample of this force in action.

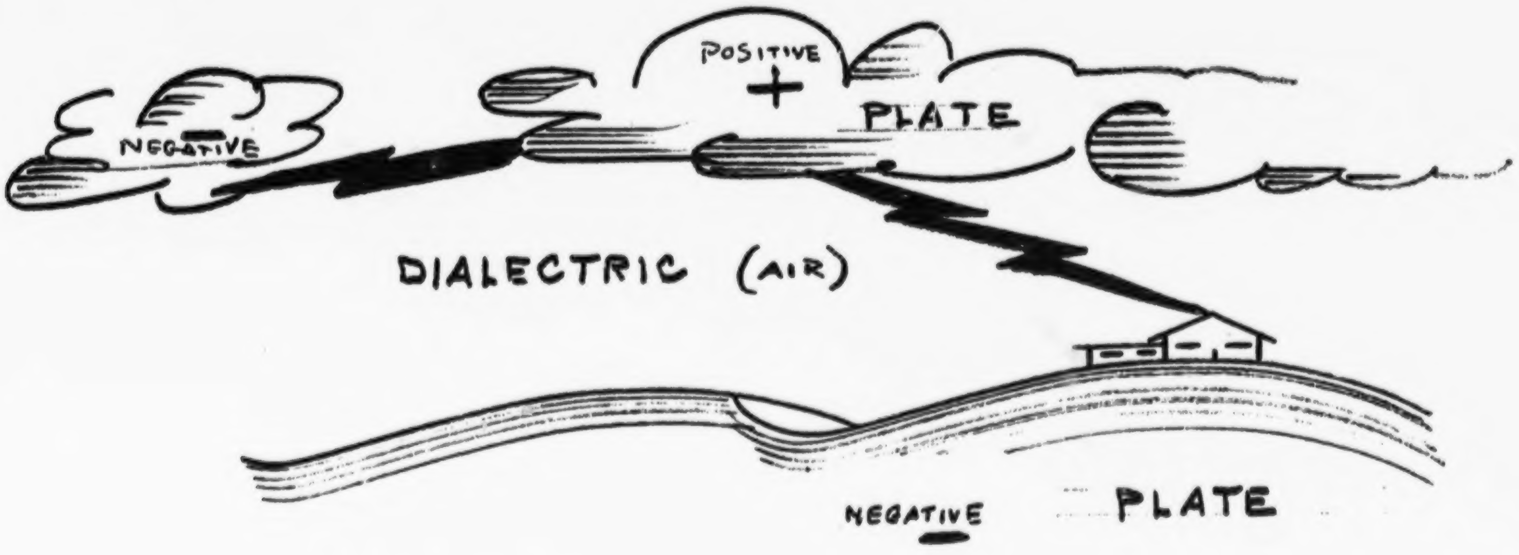
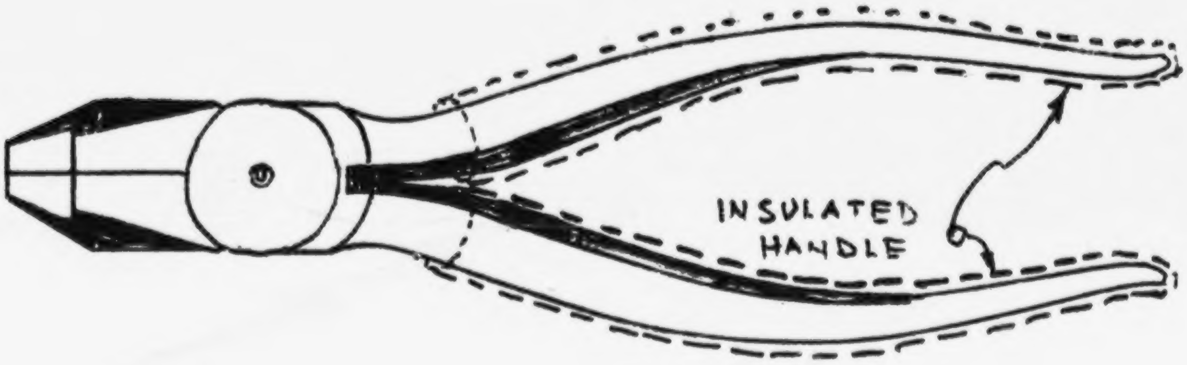

POSITIVE
+
PLATE
NEGATIVE
DIALECTRIC (AIR)
NEGATIVE
PLATE

FIG. 6

When air currents and wind and heat cause one cloud to lose some of its electrons to another cloud by friction---a potential develops between the earth and the cloud or between two clouds. When this potential builds up to the point that the electrons can overcome the resistance of the air, lightning results and the balance is restored. Since these electrons follow the path of least resistance they may release themselves through a tall tree or your house. When this happens heat is created and something burns, because wood and plaster etc. are not good conductors. A lightning rod is a good conductor and offers little resistance therefore little heat and the potential is equalized between cloud and earth through the rod without damage.

If at this point there is a basic understanding of the nature of electricity then we can begin to appreciate some of the safety precautions necessary while handling the flow of electricity.



ELECTRICIAN PLIER

FIG. 7

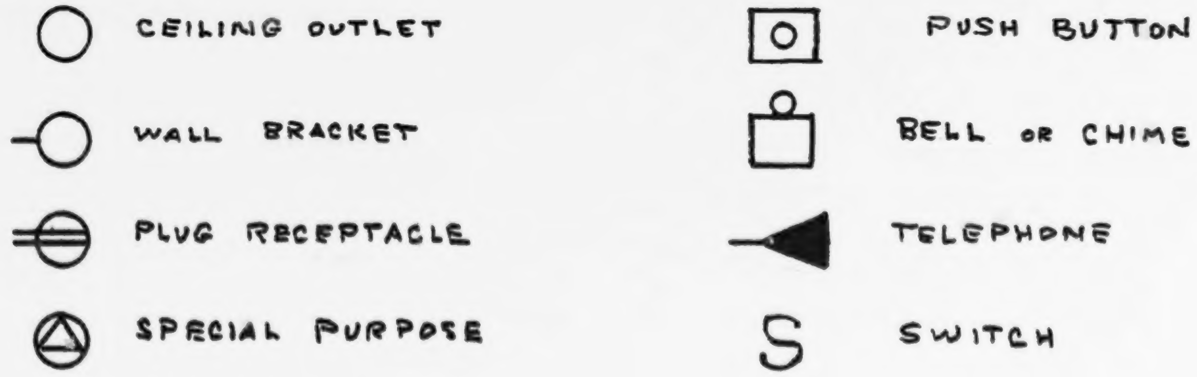
B. TOOLS & EQUIPMENT

The custodian should have certain basic tools at his disposal to handle a minimum of electrical problems.

1. (4) screwdrivers (small, medium, large, Phillips head)
2. (1) electricians pliers
3. continuity and voltage tests (homemade)
4. insulating electricians tape

Tasks which may be handled by the custodian;

1. Interpret electrical symbols on a blueprint for outlets and fixtures.


CEILING OUTLET
WALL BRACKET
PLUG RECEPTACLE
SPECIAL PURPOSE
PUSH BUTTON
BELL OR CHIME
TELEPHONE
S
SWITCH

SOME COMMON SYMBOLS

FIG. 8

2. Make a voltage and continuity test.
3. Wire splicing.
4. Replace a male plug.
5. Replace a wall switch.
6. Replace a convenience outlet.
7. Replace a lamp socket. (incadescent)
8. Replace a fuse.
9. Replace a starter.
10. Replace an appliance switch.

C. SOURCES OF ELECTRICITY

1. Chemical - Acids and alkalies act on metals and this action involves a process called ionization (an Ion is an atom or group of atoms that has become charged negative or positive due to the loss or gain of electrons.) An example of such a process is a simple wet cell battery. A strip of copper and a strip of zinc are imersed in (H_2SO_4) Sulphuric Acid. The positive ions are attracted to the copper and the negative ions are attracted to the zinc. Electrons are deposited on the zinc strip, giving it a negative charge.

UNLIKE CHARGES ATTRACT

LIKE CHARGES REPEL

If a wire is connected externally between the zinc and copper strips, electrons will begin to flow through the wire from the zinc to the copper; thus we have a current flow.

2. Magnetism - There are three kinds of magnets, natural magnets

or lodestones, permanent magnets, and electromagnets. The earth itself is a natural magnet. As basic as it may seem, magnetism is still a relative mystery. It will be sufficient to say here that natural invisible "lines of force" surround the earth and that "lines of force" can also be created artificially. A permanent magnet can be created by rubbing a needle or hard steel with a lodestone or another permanent magnet. Other methods are used such as lining up a bar of hard steel (N. & S.) and striking it sharply with a hammer. Both these methods "line up the molecules" so that the field around each molecule aids each other, creating a direct line of force through the steel.

When current is applied to a straight wire a circular magnetic field is formed. If the wire is wound around a nail or a bar of steel and current is applied the nail itself is affected by the many magnetic fields of the wire and becomes one big electro magnet.

UNLIKE POLES ATTRACT
again . . . .
LIKE POLES REPEL

This fact lends itself directly to the movement of a rotor in a motor. By creating progressive magnetic fields a small distance apart around a circle, a bar can be turned as its N. pole is attracted by a S. pole a fraction of an inch away.

3. Friction - As we have already discovered, electricity is electrons in motion. Electrons can be made to move by causing an excess of negative or positive electrons on a given substance, thereby creating a potential. An example of this creation is to rub a comb briskly on your sleeve, thus rubbing off some electrons on the comb. The comb

becomes negatively charged with excess electrons. If the comb is placed near a piece of paper, the excess negative electrons will rush off, thus creating an electron movement (electricity).

4. Heat - When two strips of dissimilar metals are joined together, and heat is applied at the joint, electrons will move from one to the other. Heat causes electrons to move rapidly. Some electrons get so violent in their movement they may fly off into space. The movement is in the form of spinning. The heat principle is used in thermo-couple instruments for measuring heat.

5. Light - Photoelectric cells are examples of using light to produce a small electron flow or current. Certain chemicals produce electron activity when exposed to light. If this chemical is applied to metal strips or surfaces the light will cause electrons to move through the metal and the rate of flow can be measured. Light meters in photography is one example of this application. Doors can be opened, windows shut, bells can be rung all by employing the principle of the photoelectric cell.

6. Pressure - Certain crystals when under pressure produce an electron movement in one direction, causing negative electrons to pile up on one surface and positive electrons to pile up on the other surface. This creates a potential between the two surfaces. A crystal "mike" is an example of this principle. The underwater submarine detector is another example of using quartz crystals to emit an impulse.

Note: It must be remembered that for any of the above 6 illustrations there must be a complete circuit to relieve the potential before we have current flow or electricity.

Nuclear electricity is the latest method of causing electrons to go into motion however this area is so new it will be sufficient to just make mention of it.

7. Fuel Cell - Scientists had long sought direct ways of converting into usable power the electrical energy that accompanies a chemical reaction. They succeeded when they produced a new current-producing device called a fuel cell.

A fuel cell receives a continuous flow of fresh liquid fuel and liquid oxidant. Hydrogen, methyl alcohol, carbon monoxide, petroleum, natural gas, and propane are commonly used as liquid fuels. Air and oxygen are most often used as oxidants.

The uniform flow of fuel and oxidant assures a constant supply of reacting substances. The energy and mass "lost" in generating electricity are therefore regularly replenished, resulting in an even flow of electric power.

D. POWER TRANSMISSION

The reader at this point should have a simple understanding of what electricity is and where most of our useful everyday electricity originates. The question should now follow; How do we get it to the house or building and how do we use it?

Electricity must be conducted over long distances, from the power generating plant to a man using an electric shaver or the housewife is

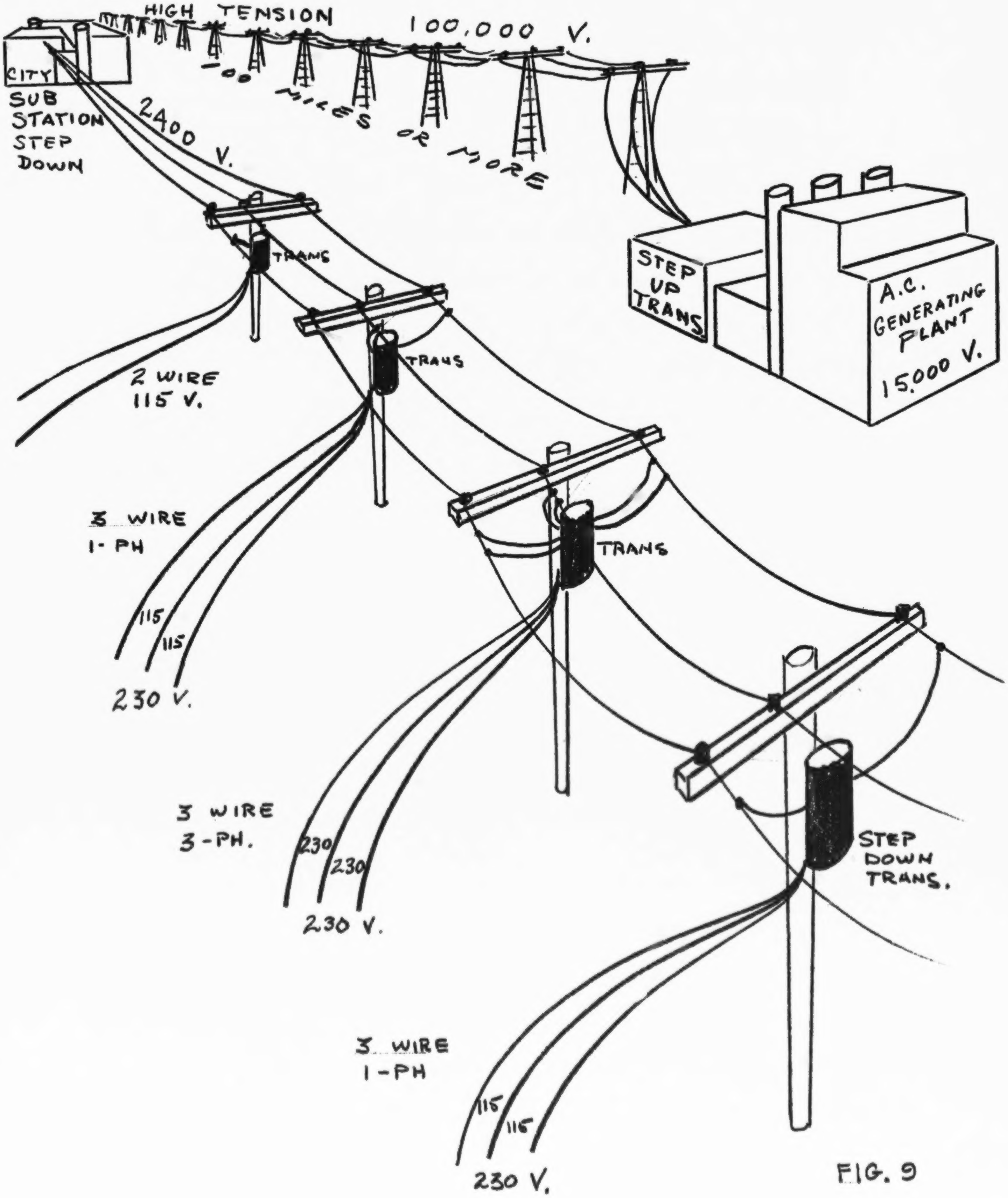

HIGH TENSION
100,000 V.
100 MILES OR MORE
CITY
SUB STATION STEP DOWN
2400 V.
STEP UP TRANS.
A.C. GENERATING PLANT
15,000 V.
TRANS
2 WIRE
115 V.
TRANS
3 WIRE
1-PH
115
115
230 V.
TRANS
3 WIRE
3-PH.
230
230
230 V.
STEP DOWN TRANS.
3 WIRE
1-PH
115
115
230 V.

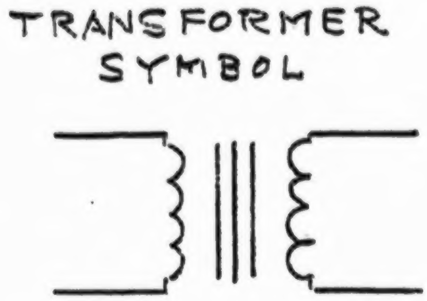
FIG. 9

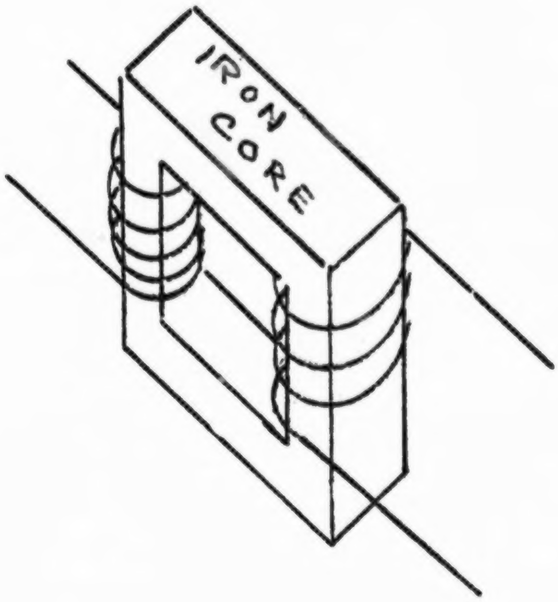
making a piece of toast. In order to satisfy a large community or city with enough electricity, large amounts must be generated. Let us trace the course of our electricity from the power plant and discuss some of the devices necessary to make it useable and safe.

Once it has been determined how much power a plant is to supply, based upon how many cities or communities it will serve, the power company has a choice to supply the necessary amperes by pushing it with low or high voltages. It will suffice to say that high voltages are used to transmit over long distances because low voltages result in a large current flow (ampere movement) and therefore at high resistance is encountered (ohms) resulting in a greater power (watts) loss.

Looking at Fig. 9 we see that the plant produces 15,000 volts, this goes through a very large step up transformer. The voltage now is 100,000 and is transmitted on what is called HIGH TENSION LINES for maybe 100 miles or more. When it reaches a city the voltage goes through another transformer, this time it is stepped down to say 2400 volts. As this 2400 volts travels to various communities, buildings, factories, rural areas etc., more transformers are used to step down the voltage and supply the correct type i.e., single phase 115 volts, single phase 230 volts, three phase 230 volts etc. (note diagram). This is why some houses have 2 wire service from the pole and others have 3 wire service.

At this point the 3 wires go through a meter installed on or in the house. From the meter the 3 wire enters a distribution box, containing various fuses and switches.


TRANSFORMER
SYMBOL



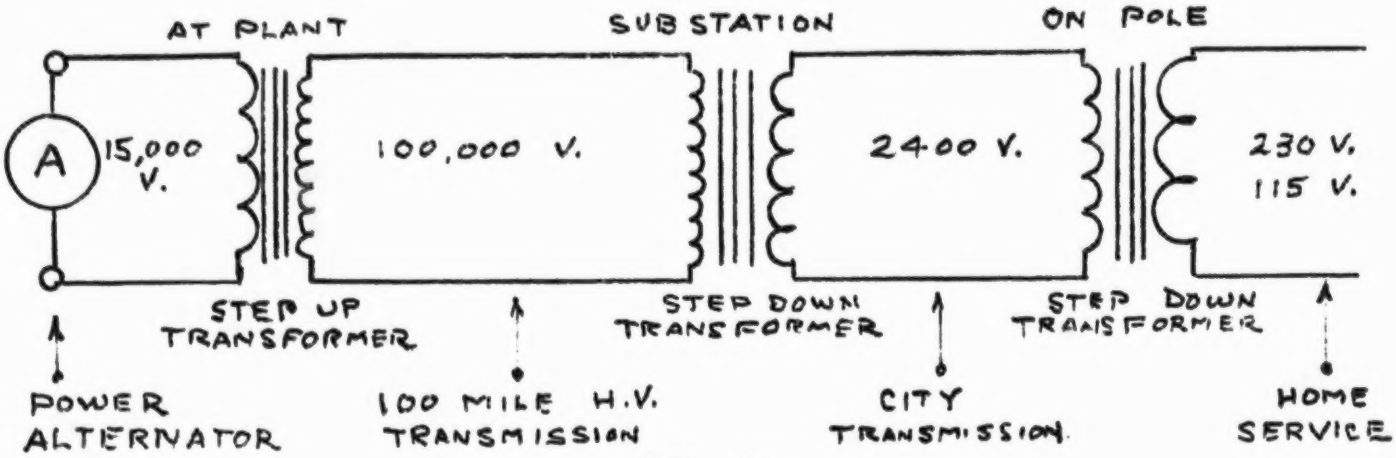

AT PLANT
SUB STATION
ON POLE
A
15,000 V.
100,000 V.
2400 V.
230 V.
115 V.
STEP UP TRANSFORMER
STEP DOWN TRANSFORMER
STEP DOWN TRANSFORMER
POWER ALTERNATOR
100 MILE H.V. TRANSMISSION
CITY TRANSMISSION
HOME SERVICE

FIG. 10

The distribution box may contain as many as 10 fuses. Each fuse may be thought of as protecting one circuit in the house. A circuit may consist of 3 or 6 convenience outlets and 4 or 5 more or less light fixtures. The average home has 100 amp service, which means when all appliances and lights are operating, the total should not exceed 100 amps. How do we know what is being consumed? We can use the power formula;

$$\begin{array}{cc} & P \\ I & E \end{array} \qquad \begin{array}{l} P = \text{Watts} \\ I = \text{Amps} \\ E = \text{Volts} \end{array} \qquad \begin{array}{l} P = I \times E \\ E = \frac{P}{I} \\ I = \frac{P}{E} \end{array} \qquad \text{Amps} = \frac{100}{110} \text{ or } .909$$

Example: A 100 watt light bulb on a 110 V. circuit would draw .909 amps or almost 1 amp. This means one circuit containing a 15 amp fuse could carry about (14) 100 watt light bulbs.

For round figures you might say 1 amp is used for every 100 watts.

Ratings on some common appliances:

Toaster - 900 watts = 9 amp

Waffle iron - 1600 watts = 16

Electric iron - 800 watts = 8

Electric heater - 2100 watts = 21

Electric drill - 300 watts = 3

Soldering iron - 200 watts = 2

Refrigerator - 100 watts = 1

Total 60 amp

This leaves 40 amps left for lighting or other appliances. (All at once.)

Not many years ago 60 amp service was common place in houses, however, with the addition of many new and advanced electrical appliances, it soon became evident that 60 amps was not enough.

E. JOB PROCEDURE

To replace a male plug.

Tools

Screwdriver
Wire strippers or sharp knife
Diagonal pliers or electricians pliers (see fig. 11.)

Procedure

1. Cut wire about 1" from plug or beyond any damaged area.

2. Using wire stripper or knife, remove insulation from each wire about 1/2".

3. Unscrew terminal on male plug and remove wire.

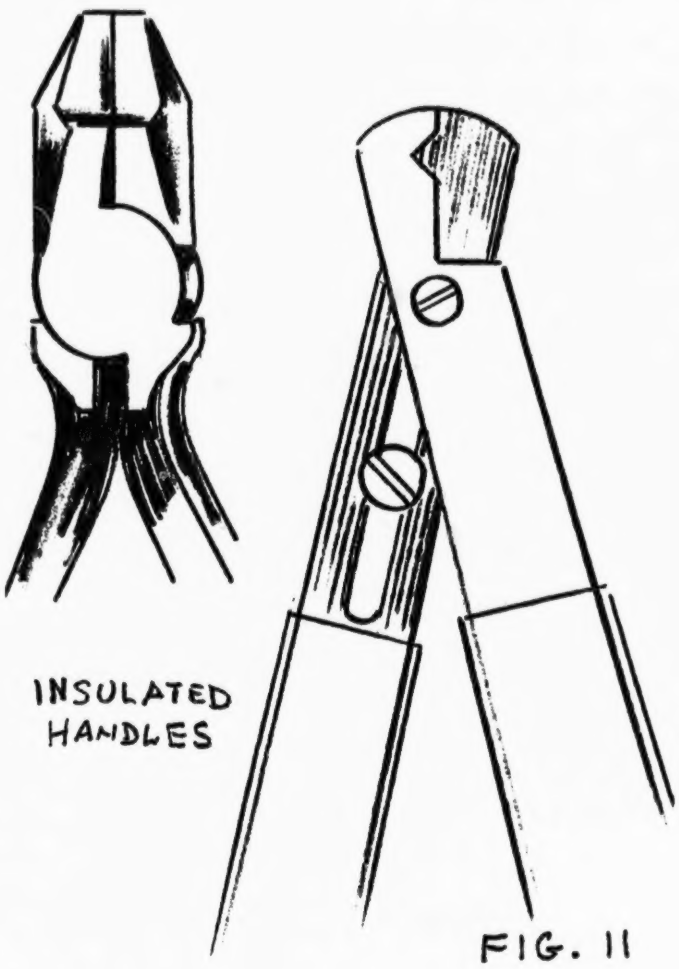

INSULATED HANDLES

FIG. 11

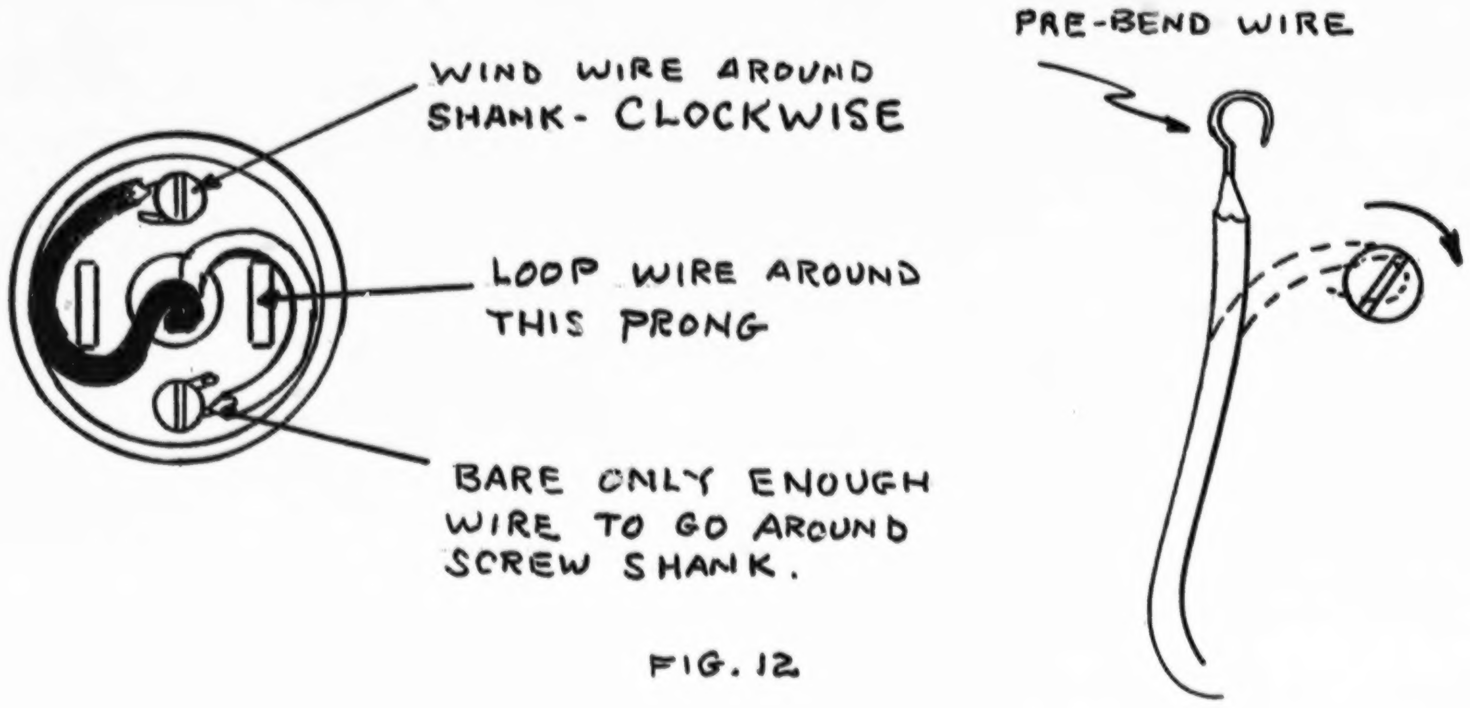

WIND WIRE AROUND SHANK- CLOCKWISE
LOOP WIRE AROUND THIS PRONG
BARE ONLY ENOUGH WIRE TO GO AROUND SCREW SHANK.
PRE-BEND WIRE

FIG. 12

4. Depending upon type of plug-tie underwriters knot at proper place in plug. See figure 12 & 13.

5. Bend wire clockwise around prongs of plug.

6. Make small loop in bare section to fit around terminal screw. See figure 12.

7. Tighten terminal screws.

8. Replace fiber insulator.

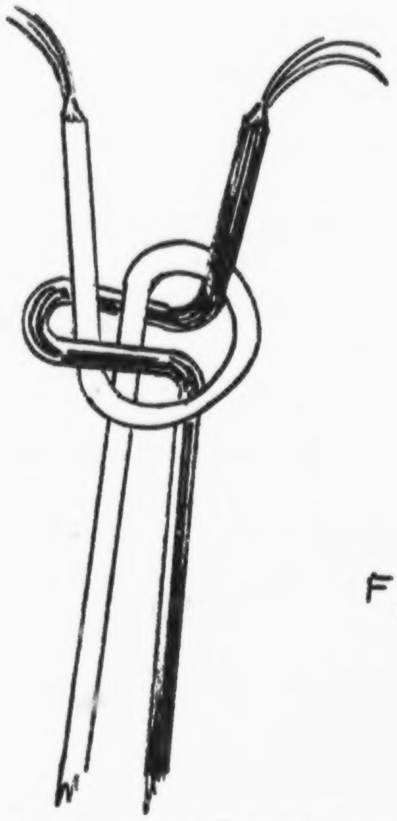


FIG. 13

UNDERWRITER'S KNOT

To wire a lamp socket.

Procedure

1. Remove lamp socket from lamp or fixture.

2. Separate outer casing (A) from base. (B)

3. Remove insulating shield. (C)

4. Loosen terminal screws and remove lamp cord. (D)

5. Untie underwriters knot (if used).

6. Slip wire out of base.

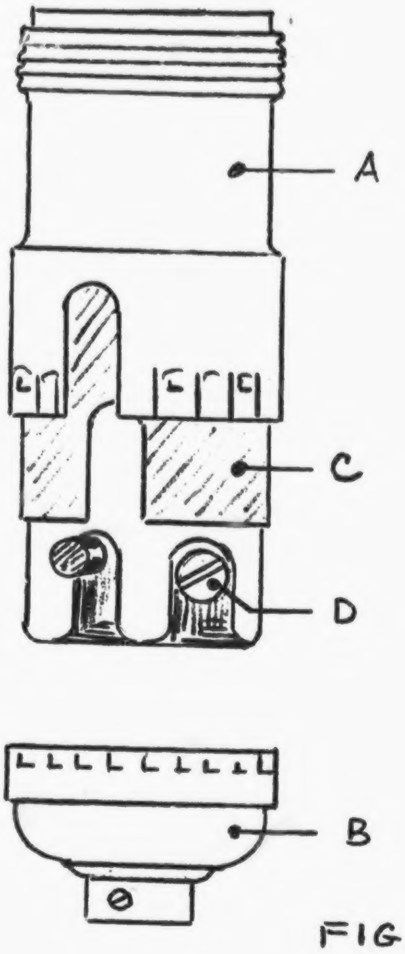


FIG. 14

7. If wire is OK, new lamp cord is not necessary.

8. If new cord is used, strip insulation (about 1/2").

9. Insert in new socket base.

10. Tie underwriters knot at proper place. (Allowing enough wire to feed to screw terminals.)

11. Make clockwise loops on bare sections.

12. Wrap one around each screw terminal (clockwise) and tighten screw.

13. Slide on insulating shield.

14. Reassemble outer casing to socket base.

15. Re-install on lamp or fixture.

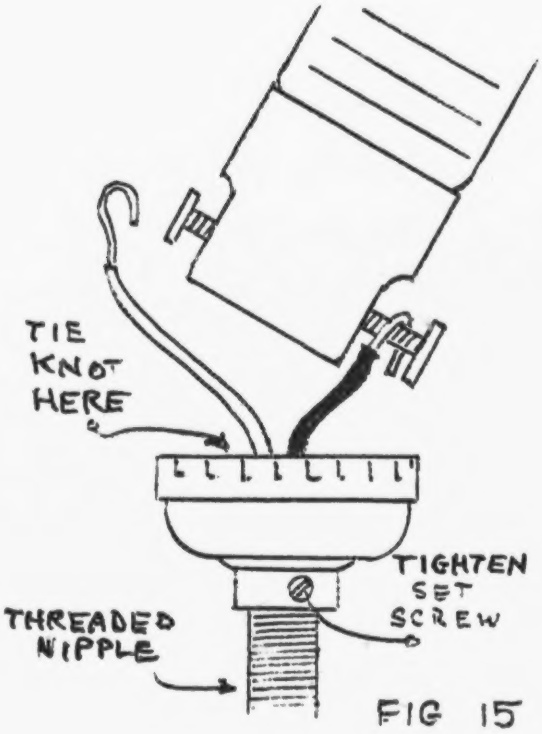


FIG 15

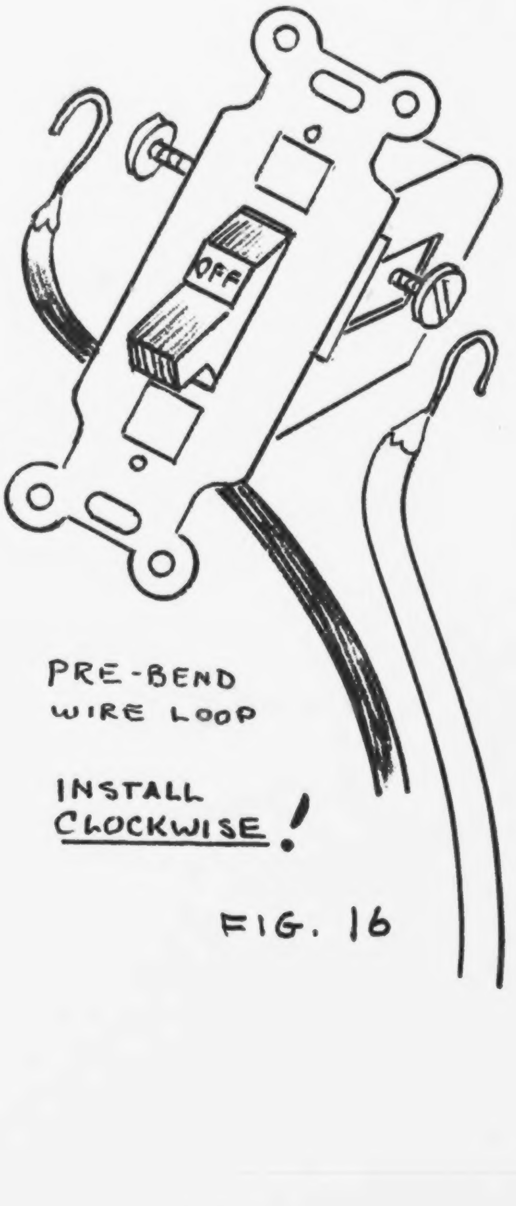
To replace a wall switch.

Procedure

1. REMOVE FUSE controlling switch.

2. Remove cover plate screws.

3. Remove screws holding switch to box.



PRE-BEND WIRE LOOP

INSTALL CLOCKWISE!

FIG. 16

4. Pull switch out of box. (Wires attached.)

5. Loosen terminal screws and remove wire. See figure 16.

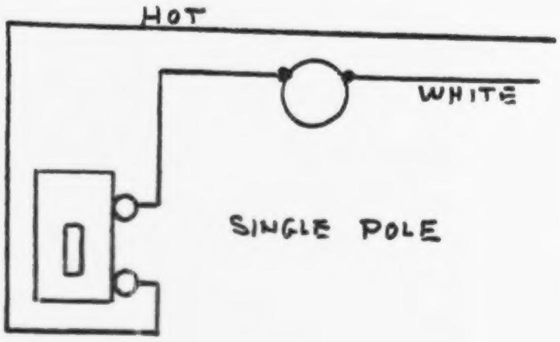
6. Select new switch (same type and rating) and reattach wires to same terminals-wire loop must be clockwise.

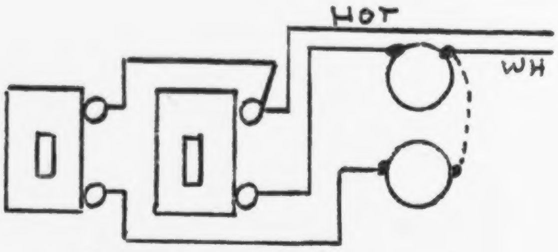
7. Push switch back in box and insert screws to fasten switch to box.

8. Replace cover plate.

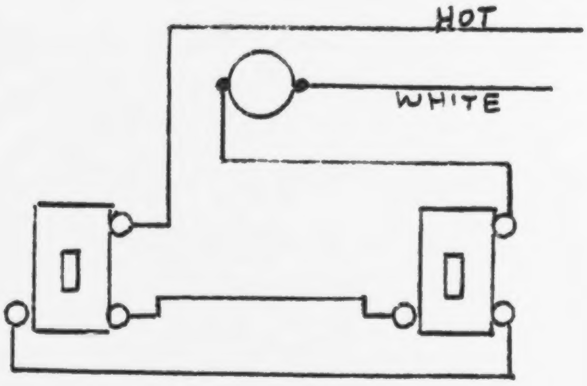
9. Replace fuse.

Note: The DOWN position is OFF on the switch.





GANG SWITCH



THREE WAY SWITCH
FIG 17

To install a feed through switch.

Procedure

1. Measure the length of the switch plus 1/2" on lamp cord.

2. Carefully separate the two wires between your measurements.

3. Cut one wire at the center.

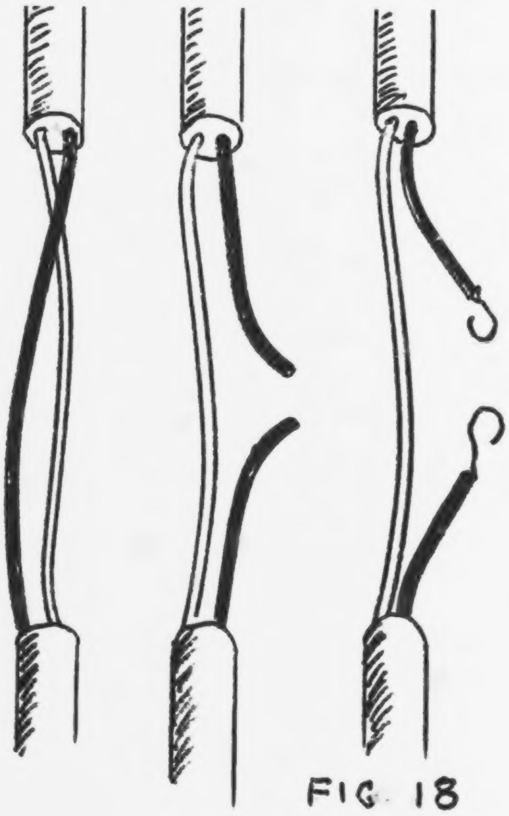


FIG 18

4. Lay wire in feed through switch and cut appropriate wire off each cut end to allow for a clockwise loop of bare wire around terminal screws.

5. Remove 1/2" of insulation off each cut end.

6. Replace wire in switch and fasten wire ends to terminal screw (wind clockwise).

7. Reassemble switch.

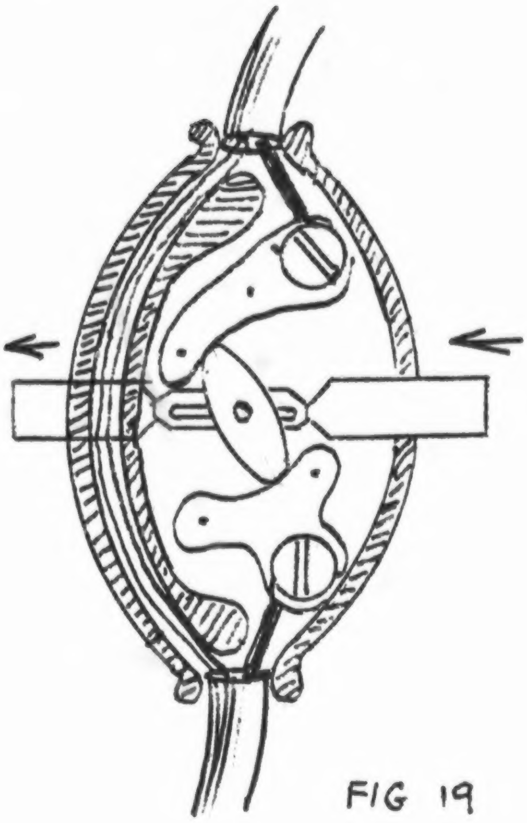


FIG 19

To replace a convenience outlet (110 V).

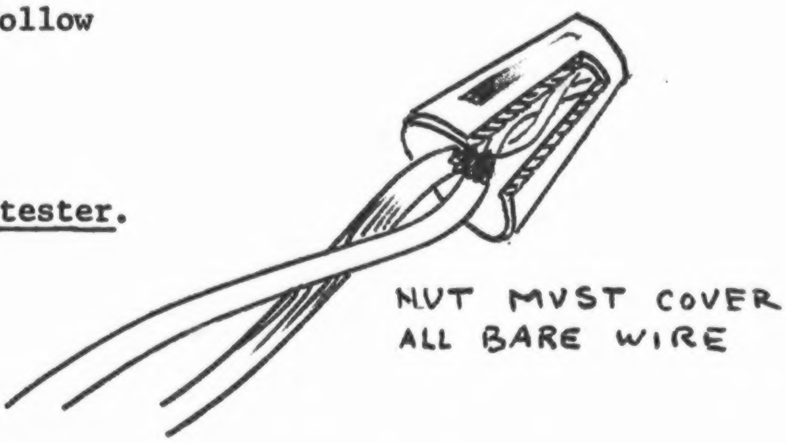
Note: The procedure for replacing a convenience outlet is the same as the wall switch. Follow each step carefully.

To make a continuity & voltage tester.

Procedure

1. Select two (110-230 V) plastic or rubber lamp sockets with at least 6" of solid wire leads.

2. Remove 3/4" of insulation



SOLDERLESS OR WIRE NUT
CONNECTOR

FIG. 20

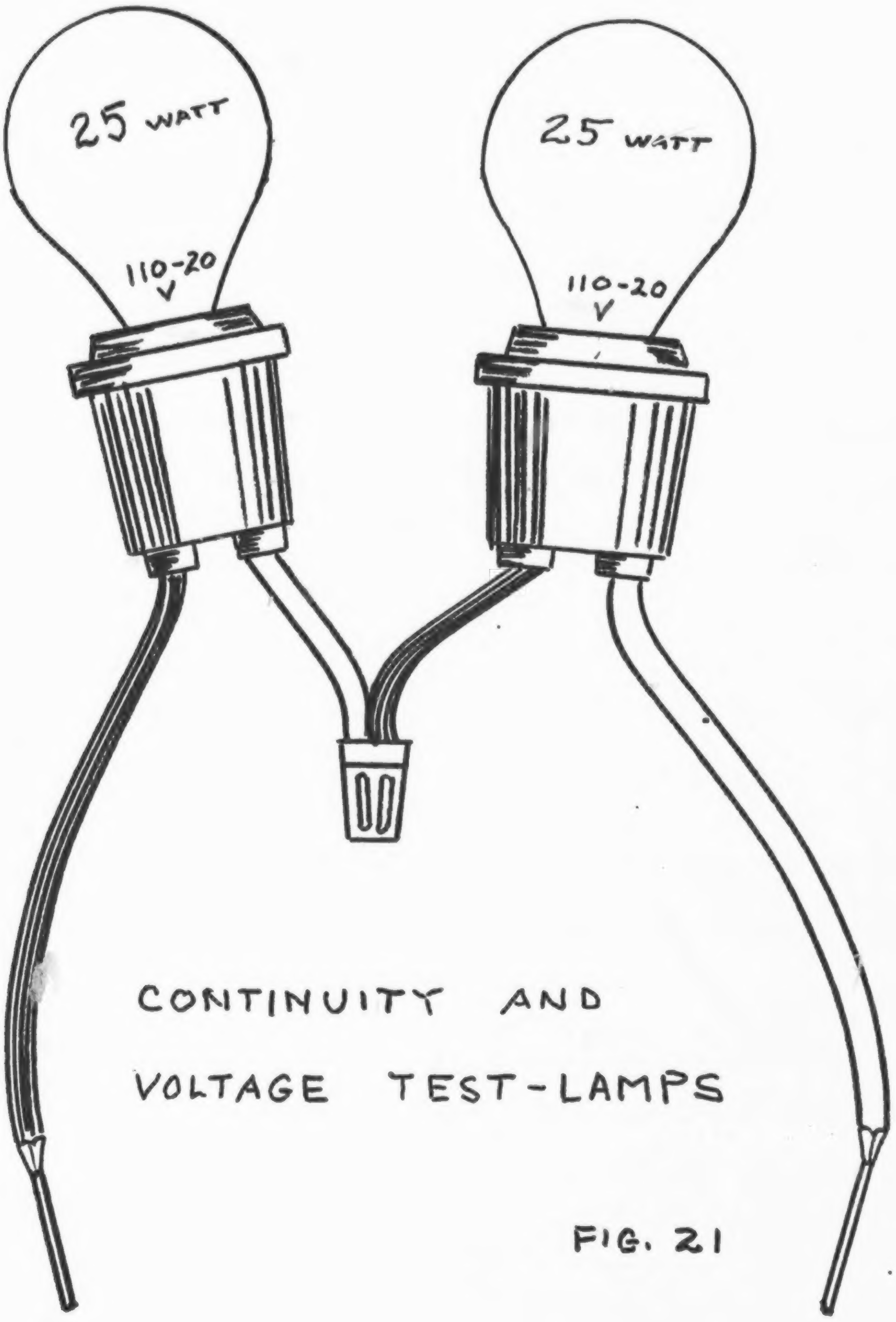
from one white and one black lead.

3. Twist the bare ends together (clockwise).

4. Fasten a solderless connector (twist clockwise).

5. Remove 1" of insulation from the other white and black lead (leave straight).

6. Use (2) 25 watt bulbs.


25 WATT
110-20 V
25 WATT
110-20 V

CONTINUITY AND VOLTAGE TEST-LAMPS

FIG. 21

To test for opens or shorts.

An "open" means that the lamp or motor or appliance fails to operate because there is an "open" circuit in the line somewhere. This may be a fuse that has blown, a switch that is broken in an open position, or a wire that is broken and separated somewhere in the line. An "open" constitutes a dialectric or insulation which impedes or prevents the continous flow of electricity.

A "short" is where the two legs of a circuit containing the potential are actually touching one another. This contact or touching means that the electricity will flow very rapidly from one leg to the other causing a high degree of heat. The heat is transfered to the fuse and the fuse will blow. If the line is overfused then the heat will destroy or burn up some other section of wire in which the electrons are racing. Most of the time the heat created at the point of the short, will cause the wire to melt and create an OPEN.

Note: If the fuse blew and the short still remains and no OPEN is created, then a new fuse will immediately blow. If a short develops in a piece of equipment, the equipment should be unplugged before inserting another fuse.

To change bulbs and fluorescent tubes.

Changing a bulb in itself is a very minor task, however the location and accessibility of the fixture can make the job almost impossible. For example an exposed bulb in a high ceiling is enough of a problem, but when it is encased in a cover which has to be unscrewed and taken off, the problem is compounded. A "bulb clamp" device can be purchased to unscrew exposed bulbs in high places. See figure 22. A complete scaffold may have to be used in places like auditoriums and gymnasiums.

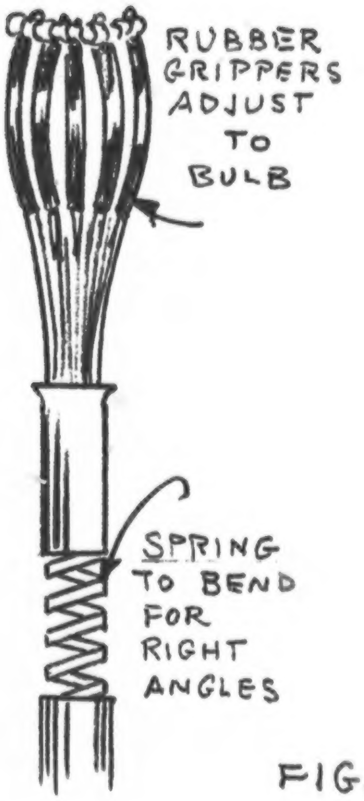
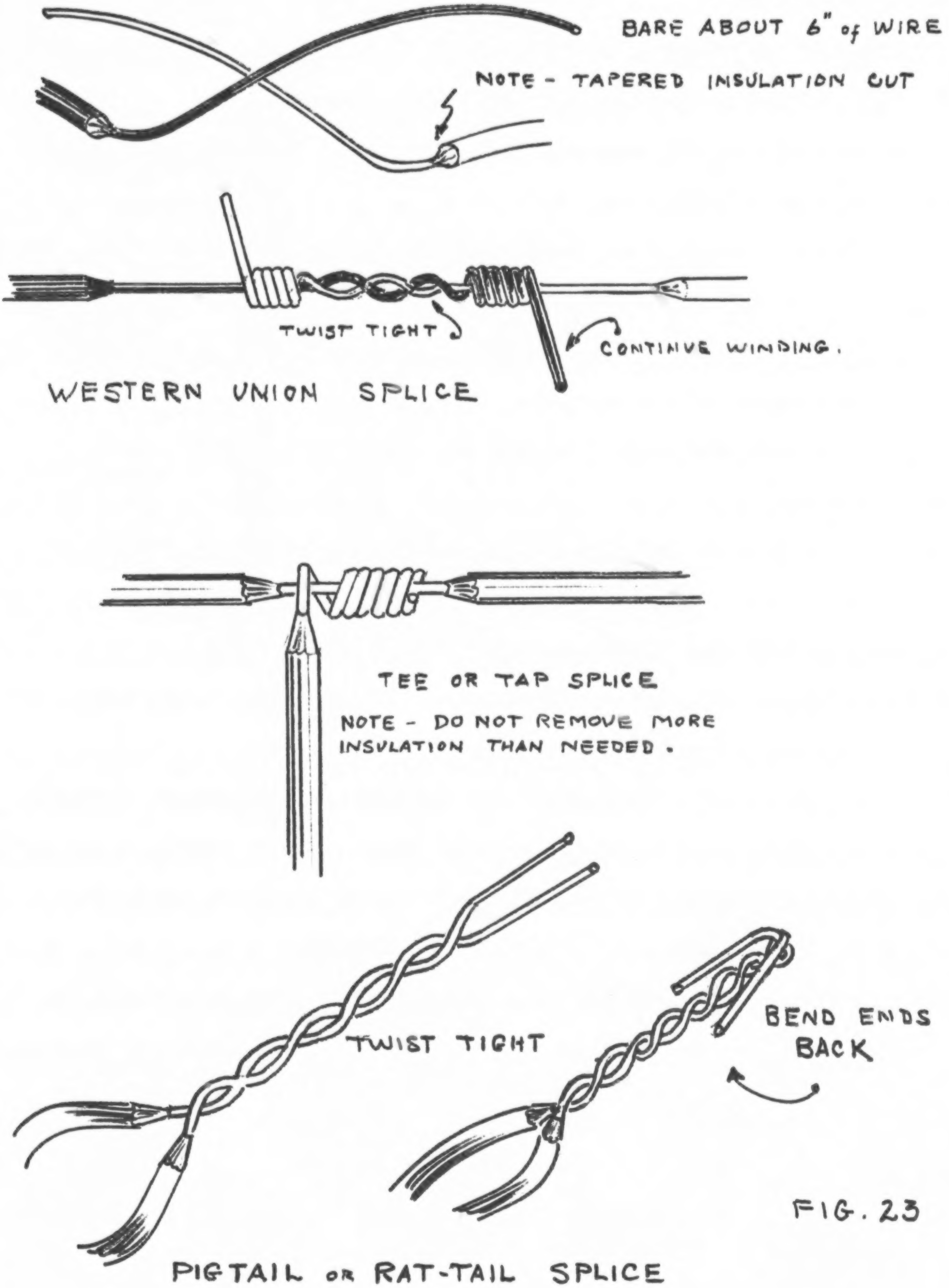

RUBBER GRIPPERS ADJUST TO BULB
SPRING TO BEND FOR RIGHT ANGLES

FIG. 22

Some bulbs and fixtures are accessible only through "catwalks" above ceilings. This can be a dangerous task, in-as-much as the ceiling may offer little resistance once the custodian steps off the "catwalk".

Fluorescent tubes offer much the same type of problem, with the additional task of having to remove light diffuser panels. The disposal of the tube is also important because the glass can be very dangerous, especially around school buildings. It is not an uncommon practice to replace all three or more of the tubes in a fixture when one goes out, thereby reducing the possibility of setting up the same scaffold in the near future.


BARE ABOUT 6" of WIRE
NOTE - TAPERED INSULATION OUT
TWIST TIGHT
CONTINUE WINDING.
NOTE - DO NOT REMOVE MORE INSULATION THAN NEEDED.
TWIST TIGHT
BEND ENDS BACK

WESTERN UNION SPLICE

TEE OR TAP SPLICE

PIGTAIL OR RAT-TAIL SPLICE

FIG. 23

44 , 45

CHAPTER II
CARPENTRY

DEFINITIONS - CARPENTRY

ADHESIVE - A substance used to hold materials together by surface attachment. I. E., cements, glue, paste or mucilage.

ALIGN - To bring parts into proper position with each other.

BASE or BASEBOARD - A board placed along the bottom of a wall next to the floor.

BASE MOLDING - A strip of wood used to trim the upper edge of a baseboard.

BASE SHOE or SHOEMOLD - A strip of wood next to the floor on interior baseboard. Also called a carpet strip.

BLIND NAILING - Nailing in such a way that the nailheads are not visible on the surface.

BOND - A joining or adhering, as of two surfaces; also a substance which causes such a joining to take place.

BRACE - An inclined piece of framing lumber used to complete a triangle, thereby stiffening a structure. Also a hand tool.

BURL - A wirl or twist in the grain of the wood, usually near a knot.

CASEMENT - A window sash which opens on hinges fastened to a vertical side of the frame. Windows with such sash are called casement windows.

CASING - Wide molding used to trim door and window openings.

CHECKS - Small splits running parallel to the wood grain, usually caused by improper seasoning.

CHUCK - A broad term meaning a device for holding a rotating tool or work during an operation.

CLAMP - A device that holds things together, often used to hold pieces of wood together while the glue dries.

CLEAT - A strip of wood fastened to another piece, usually to provide a holding or bracing effect.

CLINCH - Nails made to hold more securely by bending down the ends of the protruding nails.

COUNTERBORING - To enlarge the length of a hole by boring.

COUNTERSINKING - To recess a hole for the head of a screw or bolt.

DADO - A groove cut across the grain of a board.

DRY ROT - A term loosely applied to any crumbly decay of wood, but especially to that which, when in an advance stage, allows the wood to be crushed easily to a dry powder. The term does not accurately describe decay, since fungi which cause the rot require considerable moisture for growth.

FLASHING - Sheet metal or other material used in roof and wall conconstruction to protect a building from seepage of water.

FUNGI, WOOD - Microscopic plants that live in damp wood and cause mold, stain, and decay.

GLUE BLOCKS - Small blocks of wood, usually triangular in shape, that are glued along the inside corner of a joint to add strength.

HARDBOARD - A material made by exploding (a steam process) wood chips into wood fibers and forming them into sheets, using heat and pressure.

JAMB - The surrounding case for a door. It consists of two upright pieces, called jambs, and a head, fitted together and rabbeted.

JIG - A device which holds the work and/or guides the tool while forming or assembling wood parts.

KERF - The slit or space made by the blade of any hand or power saw.

KNOT - Cross section of a branch or limb imbedded in the wood during the growth of the tree.

LAMINATE - To build up wood in layers. Each layer is called a lamination or ply. The grain may run in the same direction in each lamination or may be turned at a right angle.

LAYOUT - A full-sized drawing showing arrangement and structural features.

LIGHT - In builders' terminology, space in a window sash for a single pane of glass; also, a pane of glass.

LINEAR - Pertaining to a line or consisting of lines. Linear measure refers to measurement along the length.

MITER OR MITRE - The joining of two pieces at an evenly divided angle. A cut made at an angle, usually 45 degrees.

MULLION - The construction between the windows on a frame which holds two or more windows.

O.C., ON CENTER - The measurement of spacing for studs, rafters, joists, and similar members in a building from the center of one member to the center of the next.

PARTITION - That which subdivides space within a building; especially, an interior wall.

Bearing Partition - A partition which supports any vertical load in addition to its own weight.

Nonbearing Partition - A partition which extends from floor to ceiling but which supports no load other than its own weight.

PENNY - As applied fo nails it originally indicated the price per hundred. The term now serves as a measure of nail length and is abbreviated by the letter "d."

PLAIN-SAWED - Lumber that is cut on a tangent to the annular growth rings.

PLUMB - Exactly perpendicular; vertical.

PORES - Openings on the surface of a piece of wood. These openings result when vessels in the wood are severed during sawing.

PUTTY - A soft, pliable type of cement, having nearly the consistency of dough, used in sealing glass in sabh, filling small holes and crevices in wood, and for similar purposes.

QUARTER-SAWED - Lumber that is cut at approximately a 90 degree angle to the annular growth rings.

RABBET - Cut made in the edge of a board to form a joint with another piece.

RIPPING - Sawing wood along the grain.

SASH - The framework which holds the glass in a window.

SCAFFOLD - A temporary structure or platform enabling craftsmen to reach high places.

SILL - The lowest member of the frame of a structure, resting on the foundation and supporting the uprights of the frame. The member forming the lower side of an opening, as a door sill or a window sill.

STUD - One of a series of slender wood or metal structural members placed as supporting elements in walls and partitions. (Plural: studs or studding.)

SPLINE - A thin strip of wood inserted in matching grooves cut or the joining faces of a joint.

STRAIGHTEDGE - A straight strip of wood or metal with opposite faces parallel. Uses to lay out and check the accuracy of work.

SUBFLOOR - Boards or sheet material laid on joists, and over which a finish floor is to be laid.

TAPER - A gradual and uniform decrease in the size of a hole.

TEMPLATE - A pattern, guide or model that is used to lay out work or check its accuracy.

TOENAILING - To drive a nail so that it enters the first surface diagonally and usually penetrates the second member at a slant also.

TONGUE - A projecting bead cut on the edge of a board that fits into a groove on another piece.

TRIM - Finish materials in a building, such as moldings, applied around openings, (window trim, door trim) or where walls join the floor and ceiling of a room (baseboard, cornice, picture molding).

TRUSS - An assembly of members, such as beams, bars, and rods, combined to form a rigid framework that cannot be deformed by the application of exterior force without deforming one or more members.

VENEER - A thin sheet of wood, either sliced, cut or sawn. Veneer may be referred to as a ply when assembled in a panel.

WARP - Any variation from a true or plane surface. In lumber it may
2 include bow, cup, crook or wind (twist).

CHAPTER II

A. UNDERSTANDING CARPENTRY:

Most of the readings that have been researched by the author indicate that the actual "tasks" performed by the custodian involving woodworking is somewhat limited, whereas the knowledgeable background required is somewhat extensive. In actual practice, many small counties in Florida prefer as their one maintenance man a person well trained in carpentry and painting, with some knowledge of plumbing, heating, or electricity.

The custodian's role is more in the area of repair rather tham new installations. School buildings appear to suffer most in furniture repair, roof repair, window and door frame repair, and some wood floor or stair repair. Whether the custodian attempts any repair involving wood measuring, cutting, replacement, etc., depends upon two factors; the county policy and the ability of the custodian. Assuming the policy allows the custodian to do the job, this section will be devoted to preparing the custodian to approach, plan and complete the task in a creditable manner.

It would be well to suggest at this point that any minor maintenance job, that calls the custodian away from his daily cleaning duties to the extent that the cleanliness and sanitation of the school is in jeopardy, should be handled by other personnel.

B. TOOLS AND EQUIPMENT:

Adequate tools must be a prerequisite for the successful involvement in any maintenance program no matter how minor.

The following list of tools may be considered basic:

1. Carpenters (framing) square
2. File and rasp (wood)
3. Glass cutter
4. Hammer (claw)
5. Nail set and assorted nails
6. Pliers and screwdrivers
7. Saws (cross cut and hacksaw)
8. Tape, measuring 6 feet
9. Tin snips
10. Wood chisel
11. Work bench with vise
12. Star Drill: 1/4", 1/2"

1. The framing square is made of high-grade steel. The tongue is usually 16" long and the blade is divided into divisions of an inch. The framing square is used to "square up stock", to test large surfaces for warpage, to create right angles, and to measure with, up to 24". See figures 201, 202, 203.

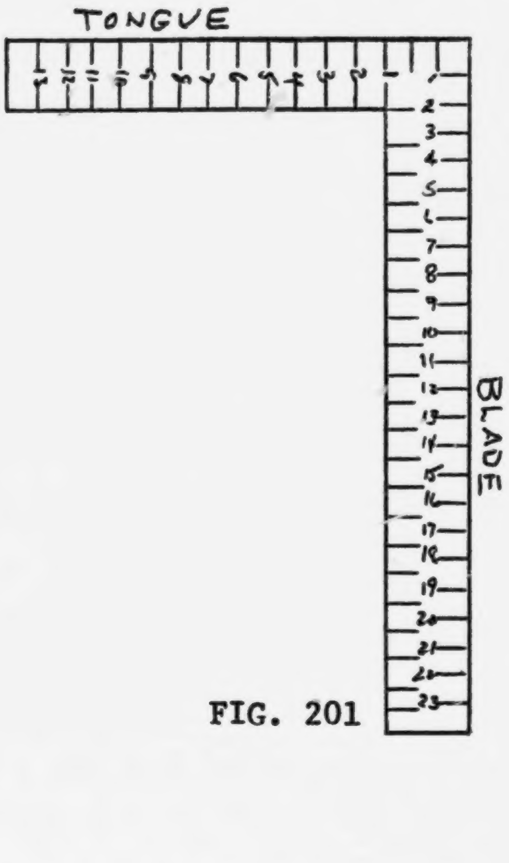


FIG. 201

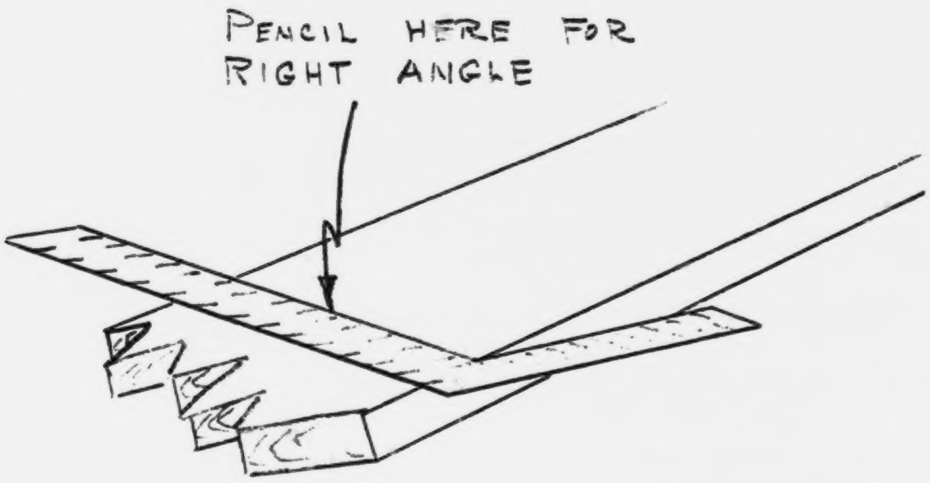

PENCIL HERE FOR RIGHT ANGLE

FIG. 202

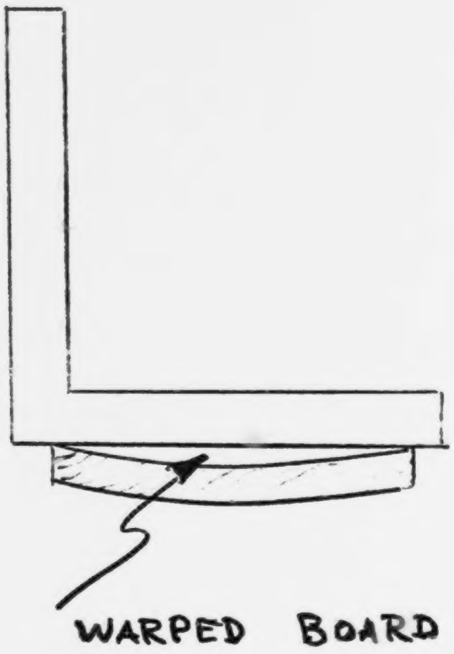

WARPED BOARD

FIG. 203

2. Wood files and rasps are used for shaping and rough smoothing edges and ends of woodpieces. Small curves and some edges are difficult to reach with other tools. The final touch is usually with sandpaper. Files and rasps come in various sizes and shapes. The size varies from 5 to 14 inches and the shape may be flat, triangular, round or half round. The file has a finer set of teeth than does the rasp, therefore the rasp would be used first for the roughest cut. Although files and rasps are purchased many times without handles, a handle should be used at all times. See figures 204, 205, and 206.

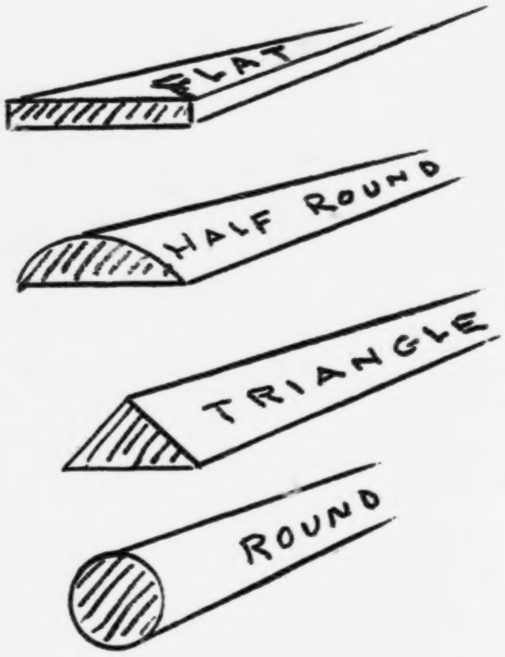

FLAT
HALF ROUND
TRIANGLE
ROUND

FIG. 204

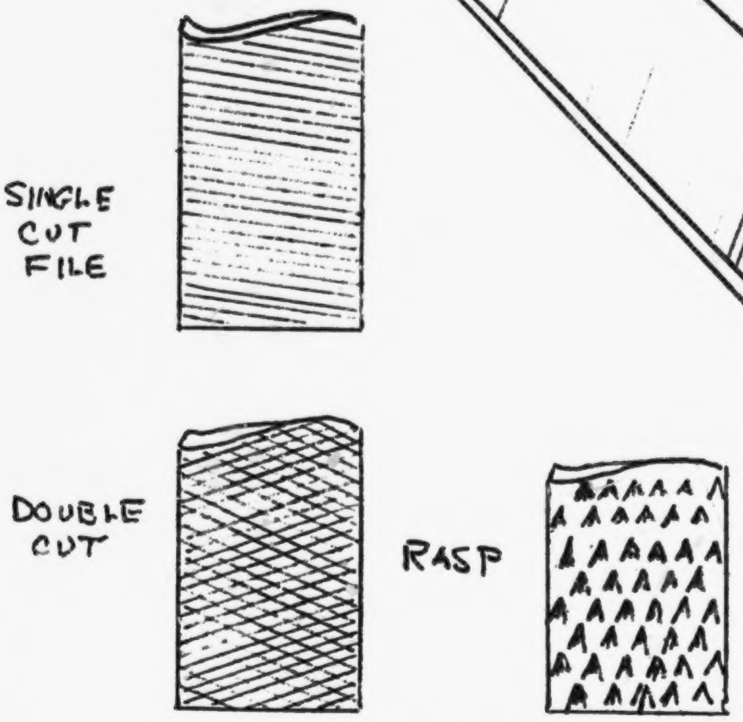

SINGLE CUT FILE
DOUBLE CUT
RASP

FIG. 205

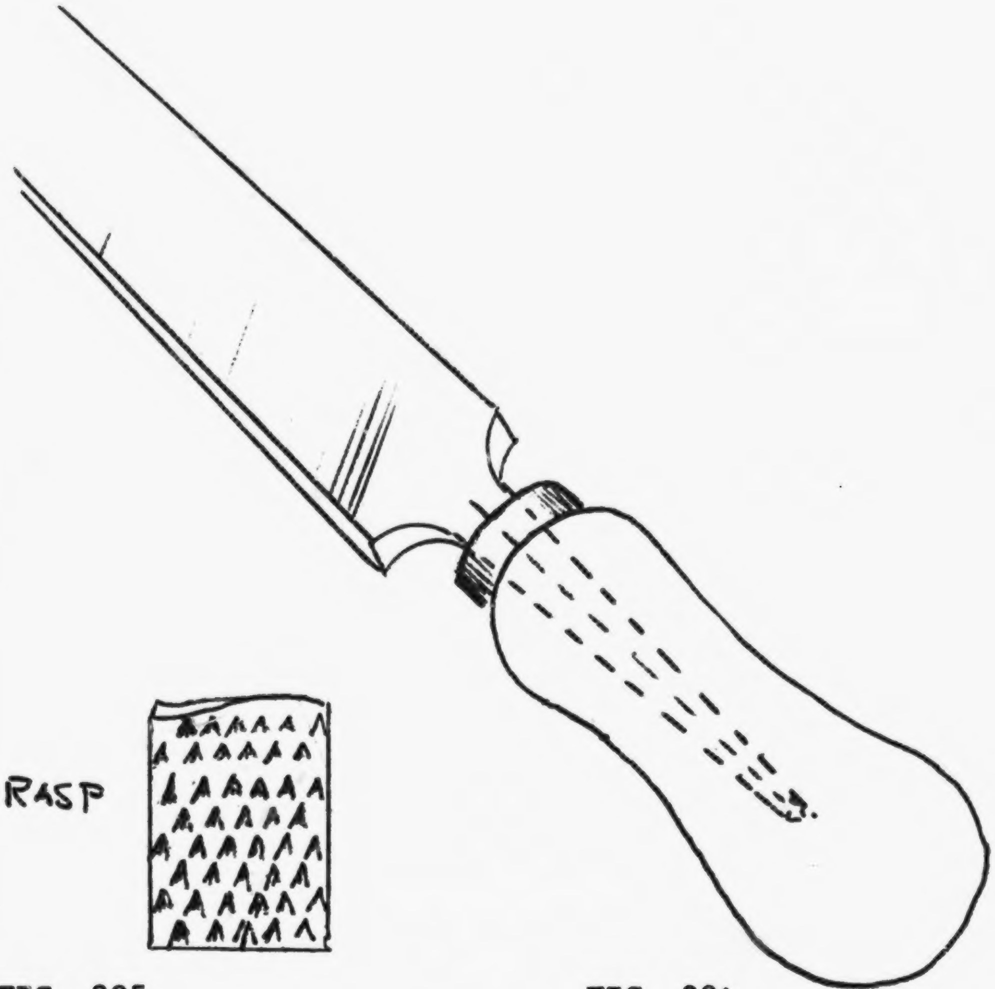


FIG. 206

3. A glass cutter is a small metal instrument used for scoring the glass and breaking off the unusable portion. It consists of a cutting edge (diamond, carborundum). The cutting edge is usually a small wheel 1/8" diameter. The outer edge also has two or three square seated grooves for gripping various thicknesses of glass -- 1/16", 1/8", 3/16". On the opposite end from the cutter is a round ball to be used for tapping or causing the glass to crack along the scored line. See figure 207.

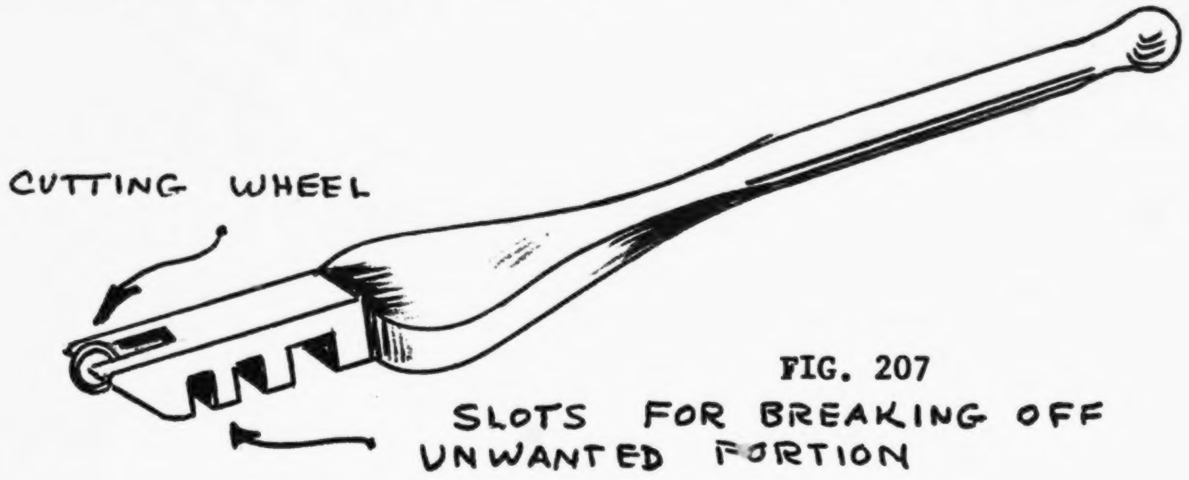

CUTTING WHEEL
SLOTS FOR BREAKING OFF UNWANTED PORTION

FIG. 207

4. The "claw" hammer is composed of a handle (usually wood) and the head. The head is a very important part of the hammer, it may be a casting or machined steel. The size of the hammer is determined by the weight of the head, i.e., 10 oz., 16 oz. etc. This tool is many times misused. See figures 208, 209, 210.

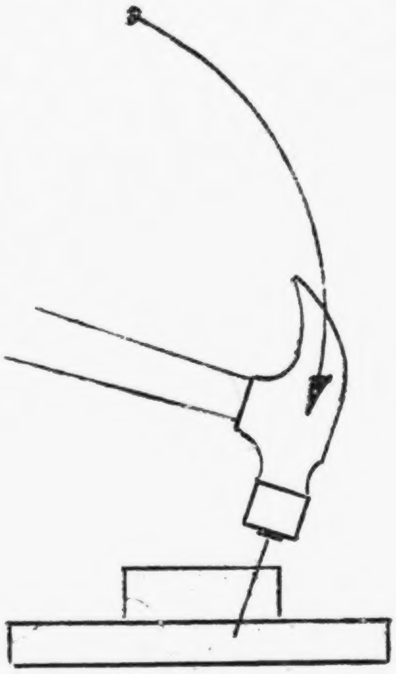


FIG. 208

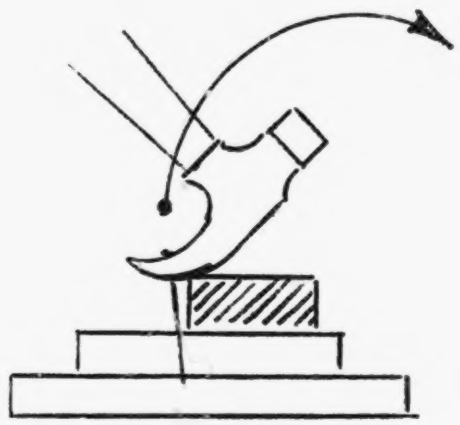


FIG. 209

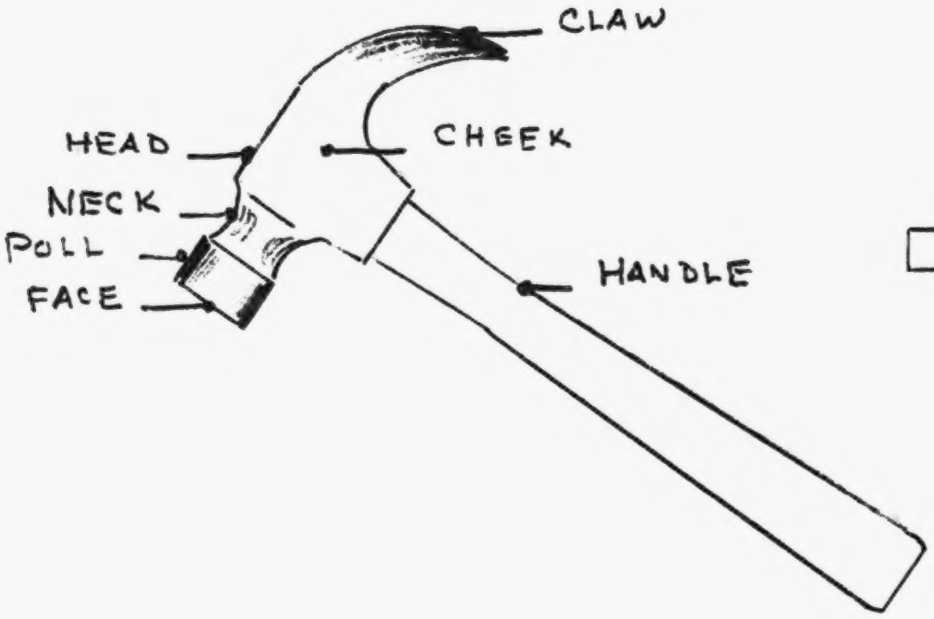

CLAW
HEAD
CHEEK
NECK
POLL
FACE
HANDLE

FIG. 210

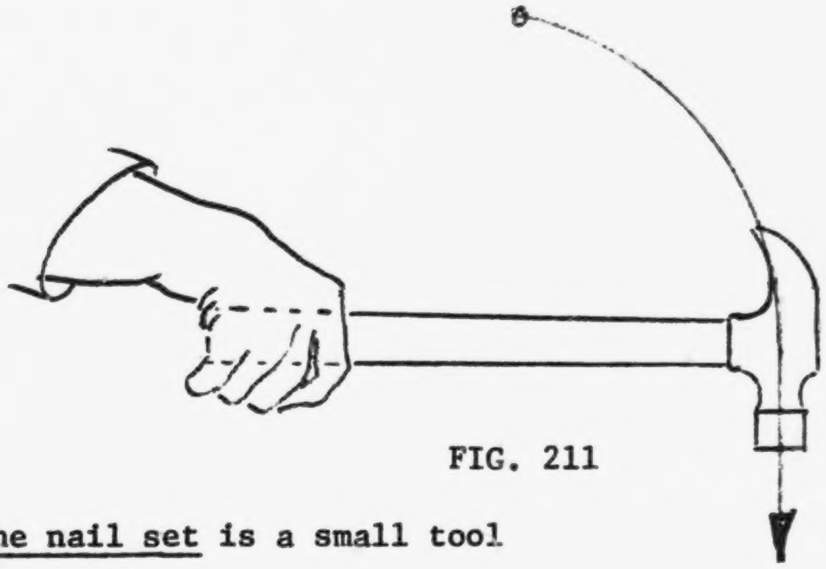


FIG. 211

5. The nail set is a small tool steel instrument used for driving the finish nail below the surface of the wood so that the resulting hole can be filled and sanded smooth. Proper nail setting results in almost obscured nail holes. See figures 211, 212.

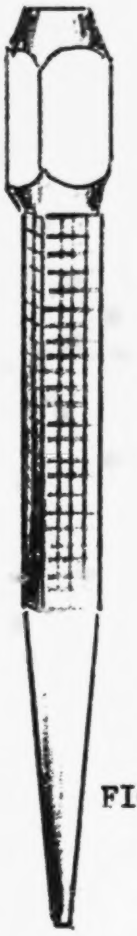


FIG. 212

6. Pliers - There are probably more varieties of this tool than any other piece of hand equipment. This is accounted for by the fact that the use intended dictates the size, shape and construction of the pliers. For all around use by the custodian, other than electrical work, probably the combination pliers is the best. See figure 213. Another type for general use is the channel-lock or tongue and groove pliers. See figure 213. Both of the above types are adjustable to grip large or small objects. Both come in various sizes from 6" to 14".

Six or eight inch pliers is about the best size since we may be limited in the quantity of tools that can be stocked.

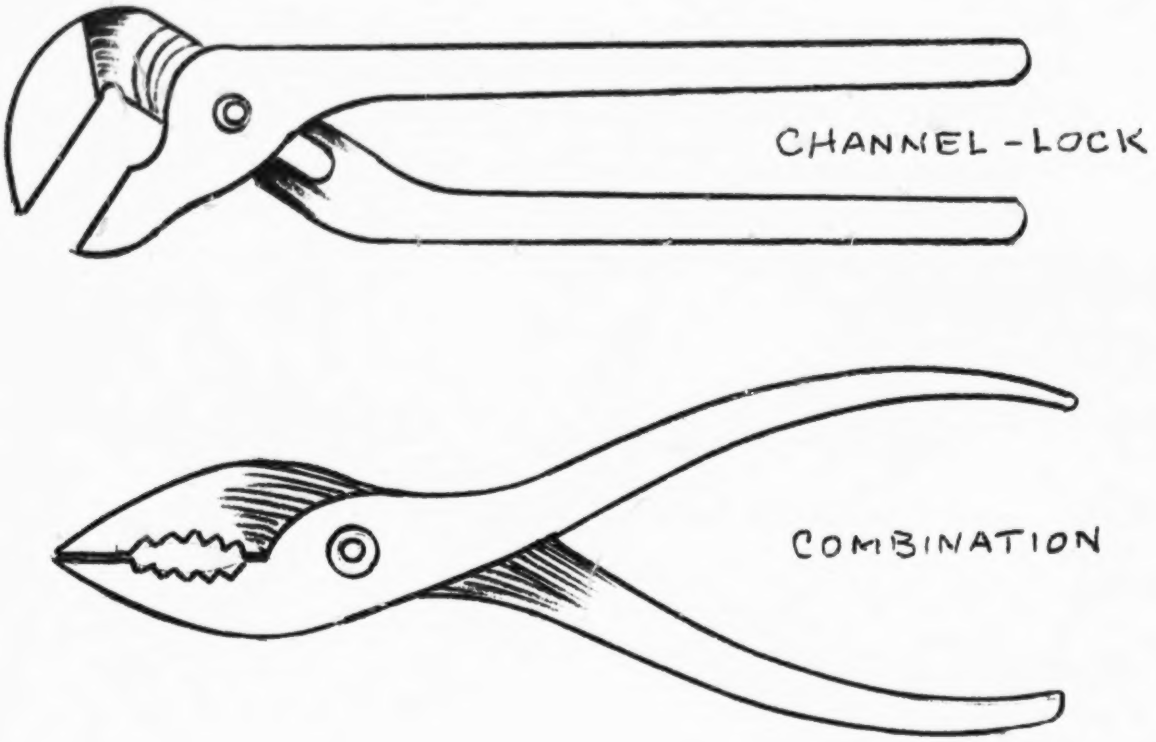


FIG. 213

7. Saws are probably the oldest type of woodworking instrument, other than possibly the hammer. Stone saws have been discovered dating as far back as the stone age. There are many types of woodworking saws -- the cross-cut, rip, back, panel, dovetail, compass, keyhole, and coping saws. A saw is classified as to its type, size and points per inch. The length of the common rip or cross-cut saw is usually 24 and 26 inches.

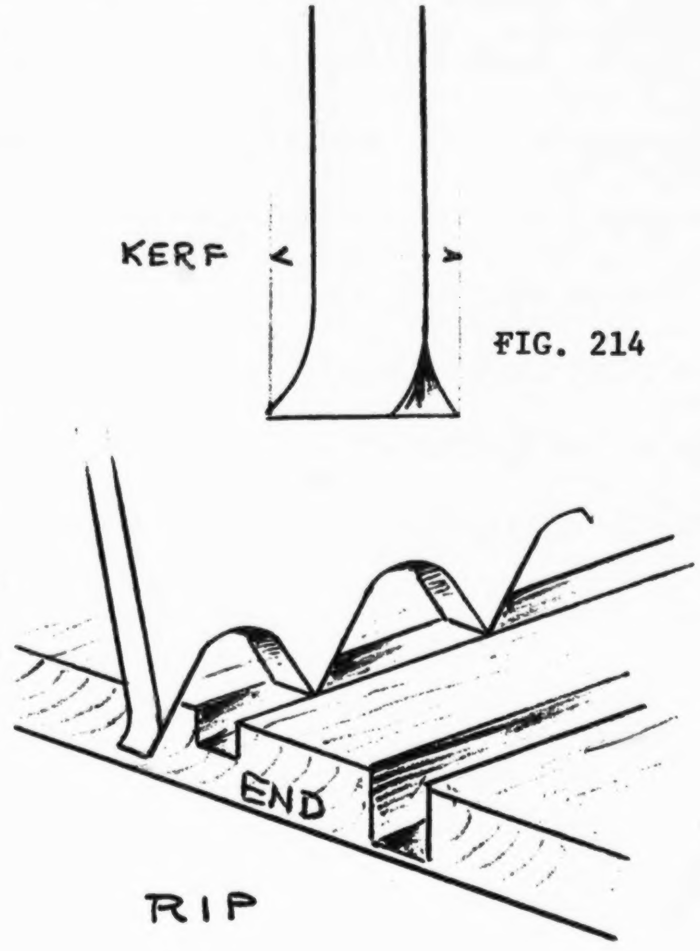
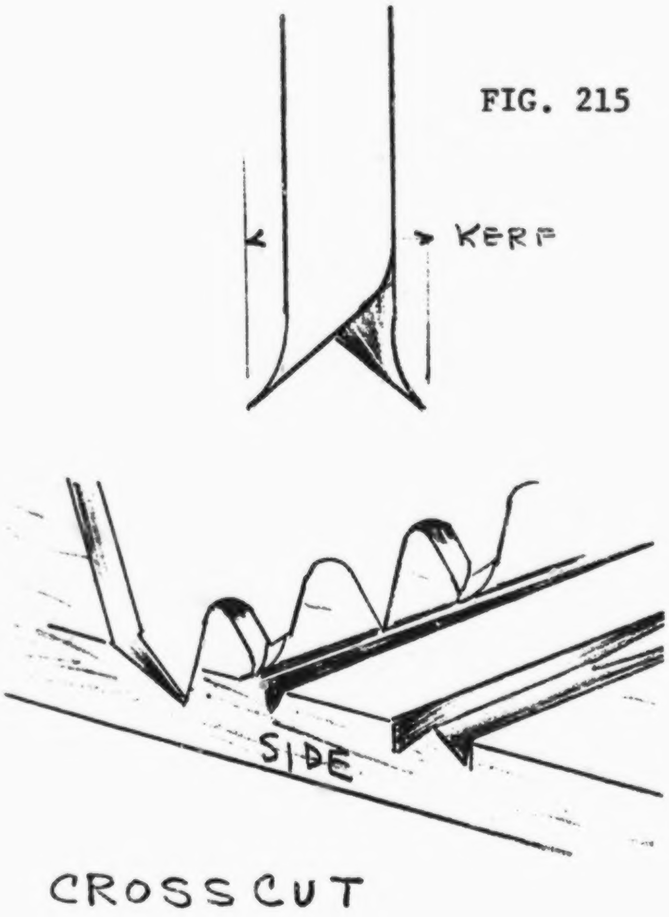


FIG. 214

FIG. 215



The number of points tells how many teeth there are per inch. (8 points = 7 inches). The "rip" saw is usually 24-26" long and is rated 8 or 10 points. The panel saw is a cross-cut saw only shorter in length, (20, 22") and is rated 10 points. The back saw is a five-toothed saw, 12 to 14 inches, very firm with a rigid steel back along the top edge. The back saw is used in conjunction with a miter-box. The dovetail is like a small back saw with extra fine teeth for close cabinet work. The compass, keyhole, and coping saws are specialized for work through small holes and hard to get places.

It only one saw is available, the 26", 10 point, cross-cut saw is the best all around. A 10 point saw produces a relatively smooth cut and the cross-cut will rip, however with some difficulty.

If two saws are available, the cross cut 26", 10 point and the 26", 5 1/2 point rip saw should be the two saws for all around use.

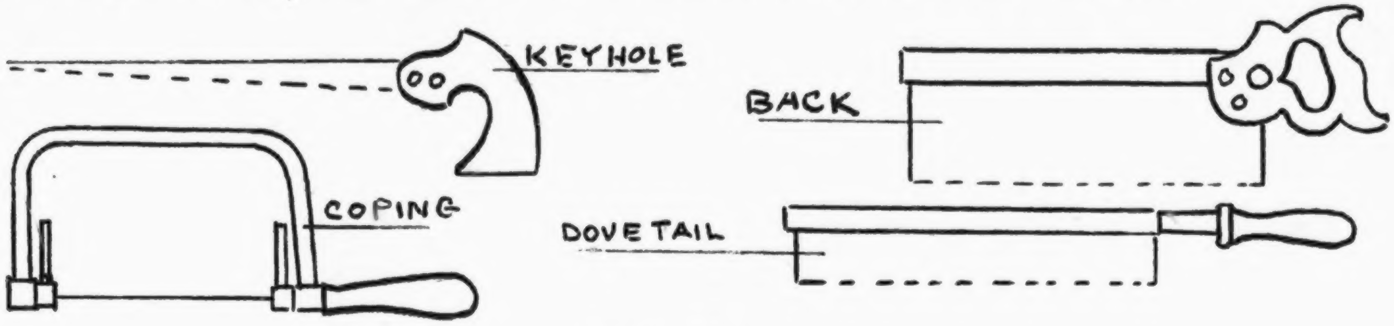


FIG. 216

8. The measuring tape is an essential part of the "tools of the trade". Accurate measurement cannot be overemphasized. Every custodian should have a 6', spring back, metal measuring tape. This tool can be used for measuring board length, room size, ceiling height, and countless other situations requiring measurement. See figure 217.

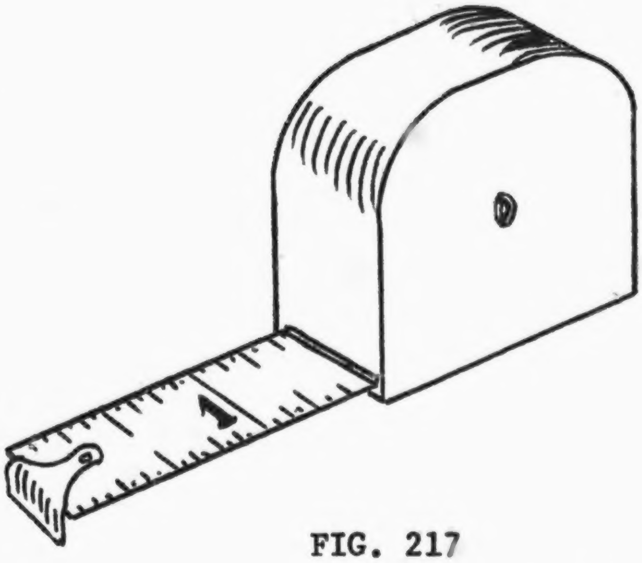


FIG. 217

9. Tin snips come in a variety of sizes and shapes depending upon the type of specialized work attempted. The best all around snip is the combination, approximately 8 to 10" long. Tin snips are used for cutting light guage metals, metal straps, heavy wire, etc. See figure 218.

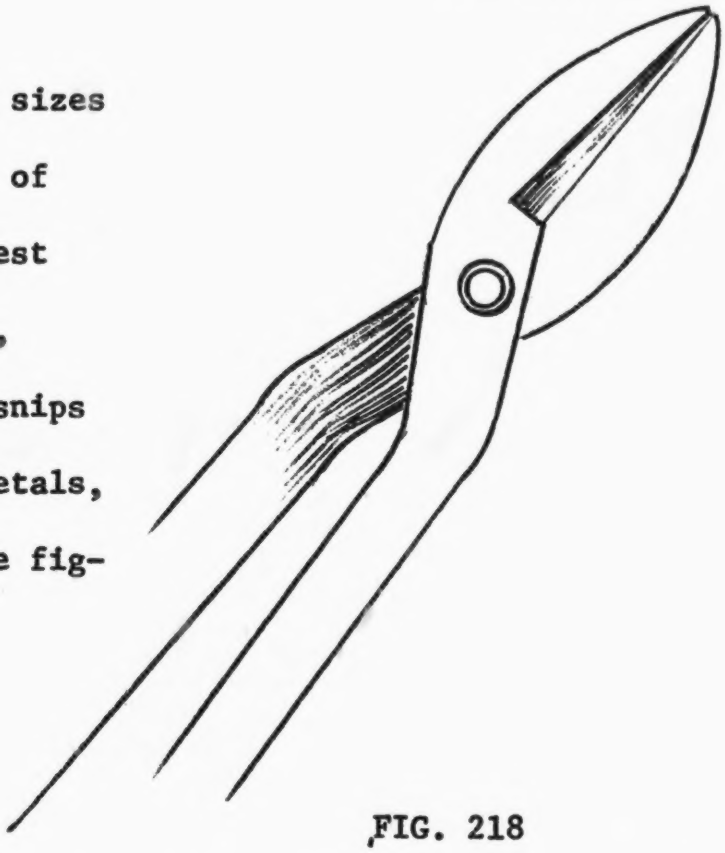


FIG. 218

10. Wood chisels come either in sets from 1/8 to 2", and also as singles. A wood chisel is essential for removing recessed sections, for door strike plates, hinges, notches, etc. The tool must be kept sharp to function

as it is intended. If one chisel is to be all that is available, the 1/2 or 3/4" size is recommended. See figure 219.

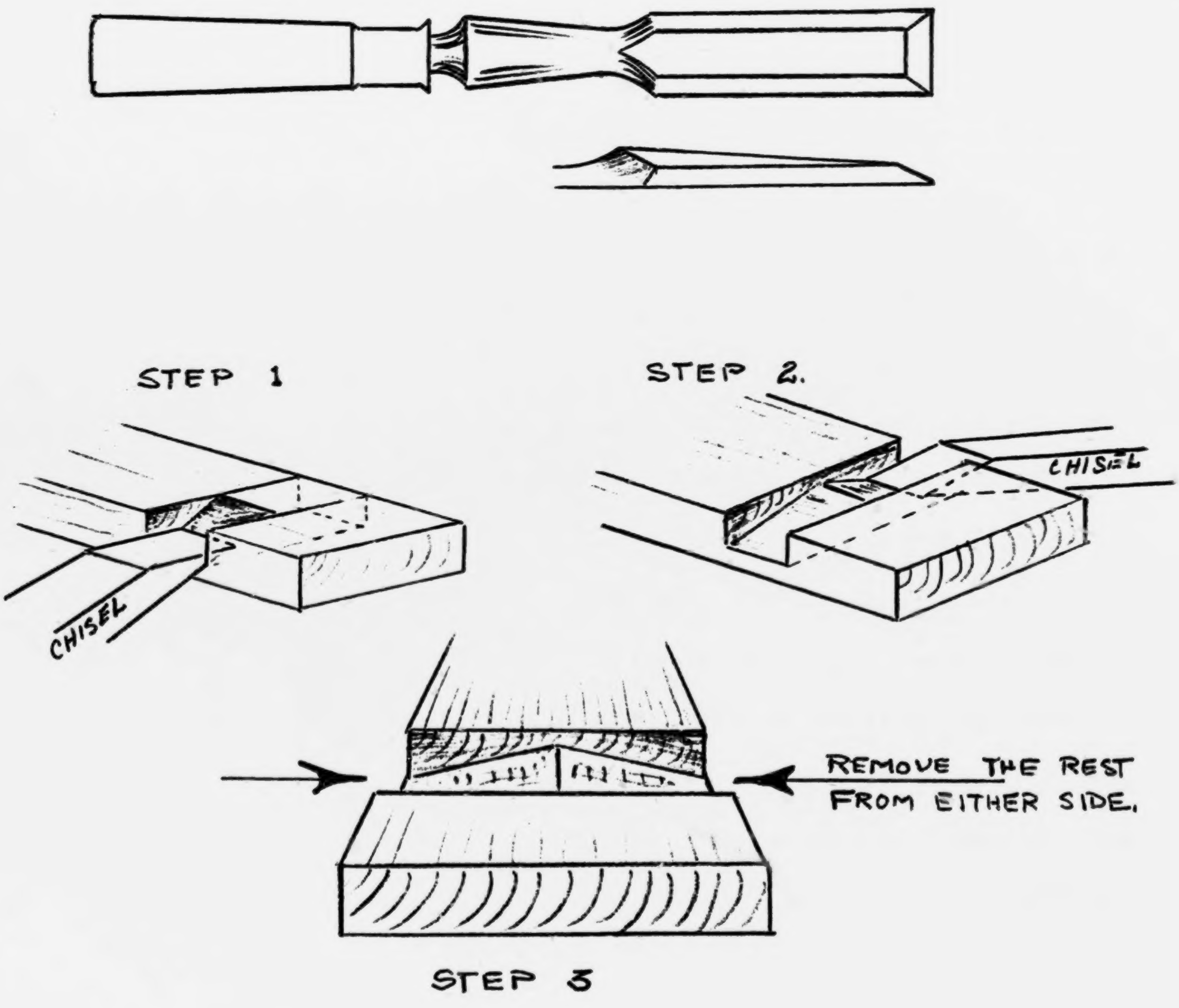
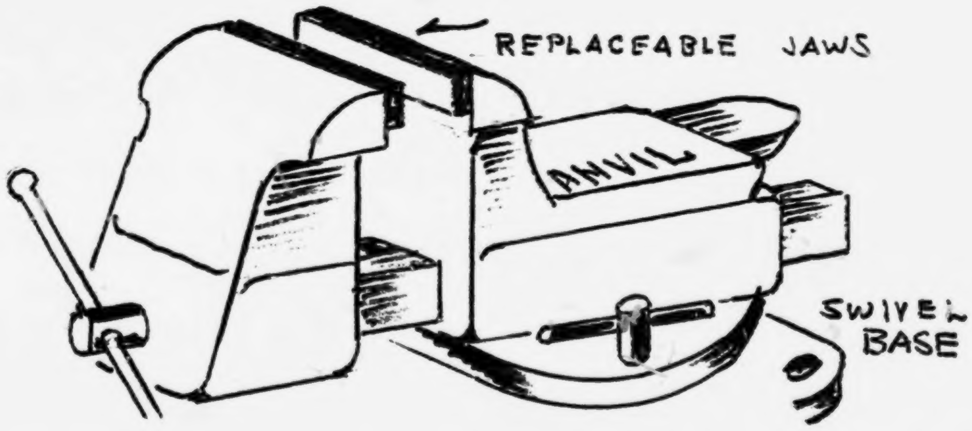

STEP 1
CHISEL
STEP 2.
CHISEL
REMOVE THE REST FROM EITHER SIDE.
STEP 3

FIG. 219

11. A work bench may consist of a highly refined, factory built unit with cabinets etc., or it may simply be sturdy lumber supported about 36" high. The most practical approach to a worktable or bench would be

one that has no open seams on the top and contains at least 8 square feet. The bench should be sturdy enough to support at least 100 lbs. in the center. A vise should be mounted on the most accessible end.

Vises come in many types and sizes, however the best all around for the custodian is a 3" to 4" jaw with up to a 6" opening and a 3" to 4" throat depth. The jaw facings should be replaceable since they are sometimes damaged or chipped. It is also advisable that the vise be swivel mounted and contain a small anvil surface. The weight may vary from 10 to 60 lbs.



POWER TOOLS

Ordinarily a course in carpentry would have an entensive section on power tools, however keeping in mind that we are relating carpentry to MINOR MAINTENANCE FOR CUSTODIANS, power tools does not enjoy the same importance. Power tools are indespensable when it comes to producing a great amount of work to exacting proportions. There is a power tool for almost every hand operation; sawing, sanding, drillings, turning, shaping, routing, planing, carving, edging, cutting, hammering, etc., however, due to the limited amount of woodworking the custodians should be called upon to do, power tools are not one of the necessities.

FASTENERS

By definition, fastening may be considered the joining together of two or more similar or dissimilar materials. Nails are one of the most common type of fastener; they come in various sizes and shapes. See figure 220. The selection of the proper nail is most important from both an appearance and a safety standpoint. The strength of the fastening or how well "it holds" depends largely upon the size of the nail and the direction in which it is driven. If appearance also enters the picture, then a nail should be selected that shows very little or maybe it should be set and the hole filled and sanded smooth.

a. Nail size is designated by the term "penny". The "common" nail is larger in diameter and has a head. It is used for rough work and where the appearance is second to the strength factor. Common nails are made in the widest range of sizes, i.e., from 4d to 60d (d means penny).

b. "Box" nails are smaller in length and narrower in diameter. They are used for lighter work such as crates and boxes. Some box nails are barbed for the full length of the shaft. The range in size is from 4d to 16d.

c. "Finishing" nails are exactly as the name implies. When appearance becomes a factor, a finishing nail should be used. A finishing nail has a small round head and is usually "set" below the surface of the wood, so that the resulting hole may be filled and smoothed over virtually hiding the nail hole entirely. Finishing nails range in size from 3d to 9d.

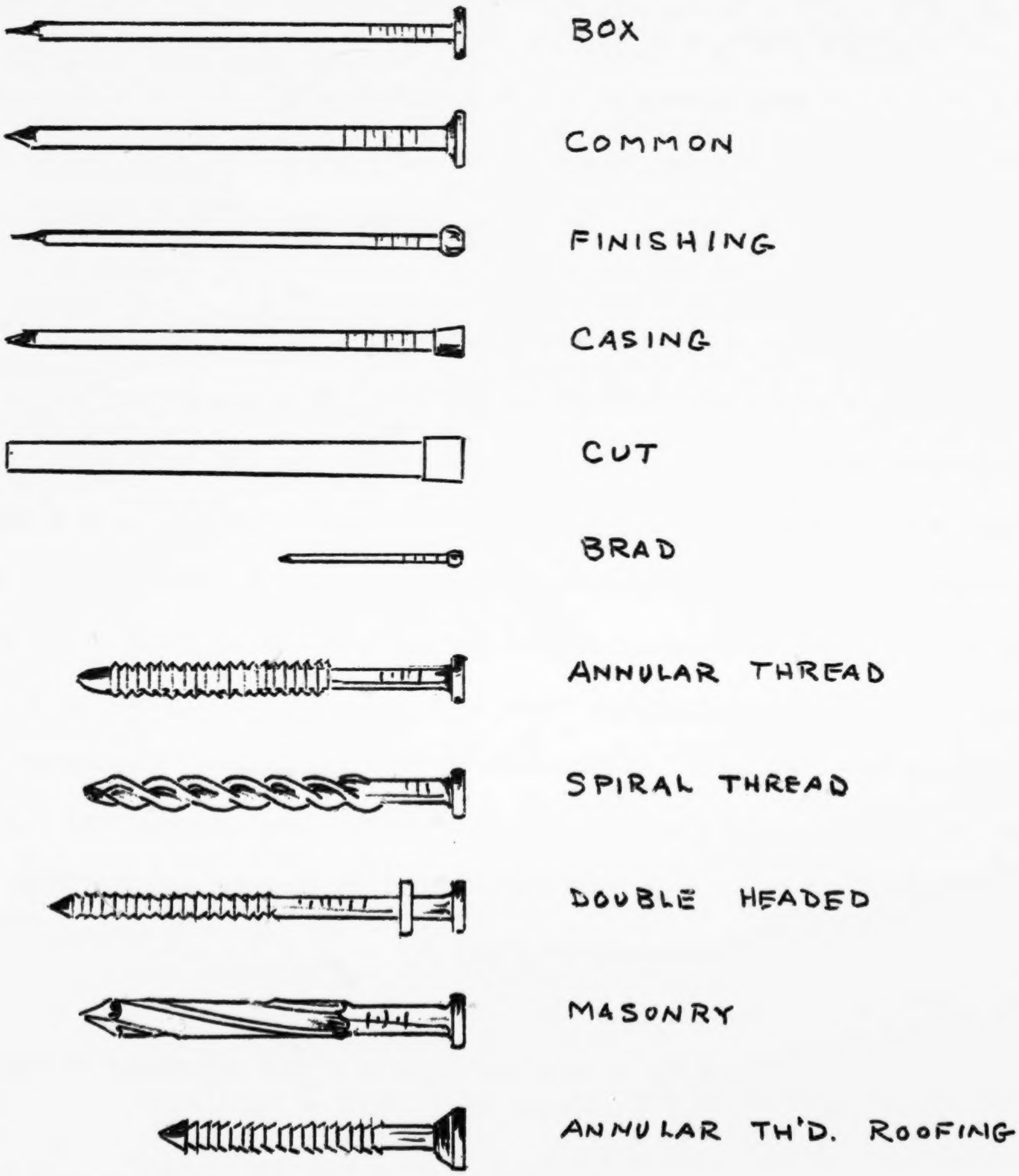

BOX
COMMON
FINISHING
CASING
CUT
BRAD
ANNULAR THREAD
SPIRAL THREAD
DOUBLE HEADED
MASONRY
ANNULAR TH'D. ROOFING

FIG. 220

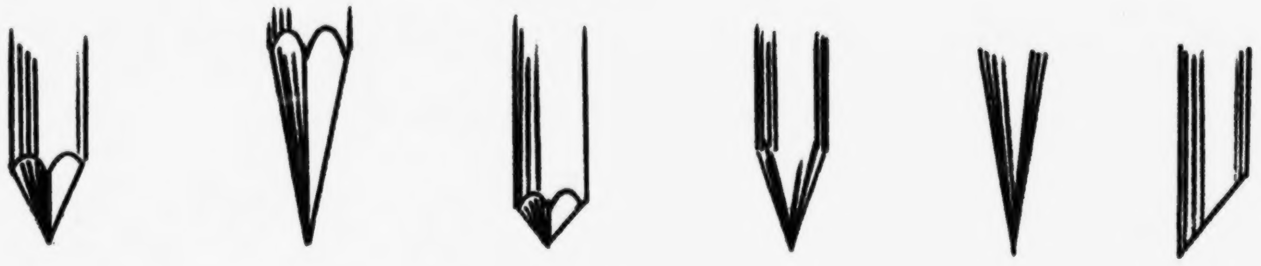


FIG. 221

d. "Casing" nails are very similar to finishing nails, however the head is cone-shaped, giving it better holding power. Casing nails are used for interior trim and some cabinet work. Some are resin coated to increase the holding power. The range in size for the casing nail is usually from 4d to 10d.

e. "Brads" are just like small finishing nails. Brads are used for very fine work where strength is not of primary importance, however appearance is uppermost. The brad, when driven and set leaves only a small obscure hole and can be hidden very easily. In many cases gluing accompanies the use of the brad. The range in size is usually 1" or less. (Notice for this small nail the term "penny" changes to parts of an inch.)

f. "Special purpose nails" come in a wide variety. A few examples are shown in Figure 220. These nails come in many types of material such as copper, iron, steel, aluminum and bronze and are designed for maximum holding power. The various corrugation designs and coatings tend to increase the cost considerably.

There are a few rules to follow when selecting and using nails:

1. The nail should be 3 times the length of the thickness of the first board.
2. The diameter of the nail should not be too thick so as to split the wood.
3. Drill pilot holes in hard woods such as maple, oak, etc.
4. Don't put nails in your mouth while working.

g. Staples and corrugated fasteners are also used to join materials. See figure 222. The corrugated fastener is used to join two pieces of the same size wood, at corners, or butt joints as in picture framing. The fastener is driven at a right angle and across the seam. See figure 222.

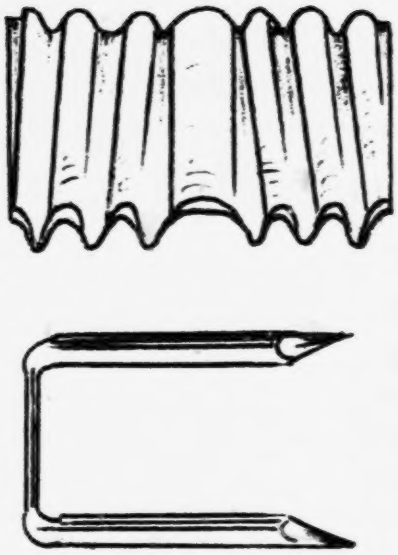


FIG. 222

h. Wood screws -- screws provide much more holding power than nails, and also provide for disassembly of the project. They are considerably more expensive and therefore are used usually in finer cabinet work, higher priced furniture construction.

Wood screws are classified as to length, diameter, head shape, and type of material. Screws are manufactured in sizes from 1/4" to 6" in length and range in diameter from 0 to 24. See figure 223. The shape of the head may be round, flat or oval. The material may be brass, steel, iron, or aluminum. An example of proper ordering for wood screws would be: 1 1/2 - #10, round head, bright. This would indicate a 1 1/2", .190 diameter, round standard slotted head made of bright steel possibly nickel plated. The head of the screw may be standard slotted or phillips head. See figure 223.

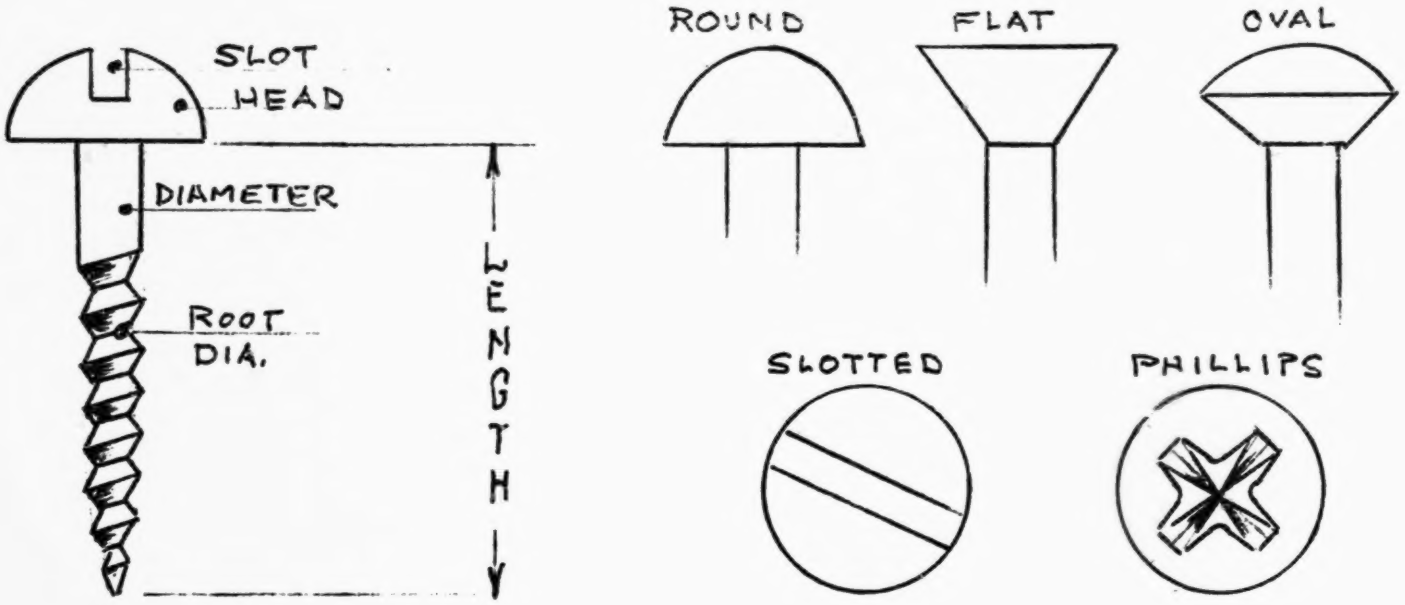

SLOT
HEAD
DIAMETER
ROOT
DIA.
LENGTH
ROUND
FLAT
OVAL
SLOTTED
PHILLIPS

FIG. 223

The proper method for driving a wood screw is to:

1. Select the proper size of screw (approximately 2/3 of the screw should be in the second piece of wood). Where thickness of material will not permit, use "good judgement".
2. Select the desired type head and finish.
3. Drill a pilot hole in both pieces to be fastened. (The size to be the same as the "root" diameter of the screw.) See figure 224.
4. Drill a shank hole in the first piece only. (The size is the same as the diameter of the screw.)

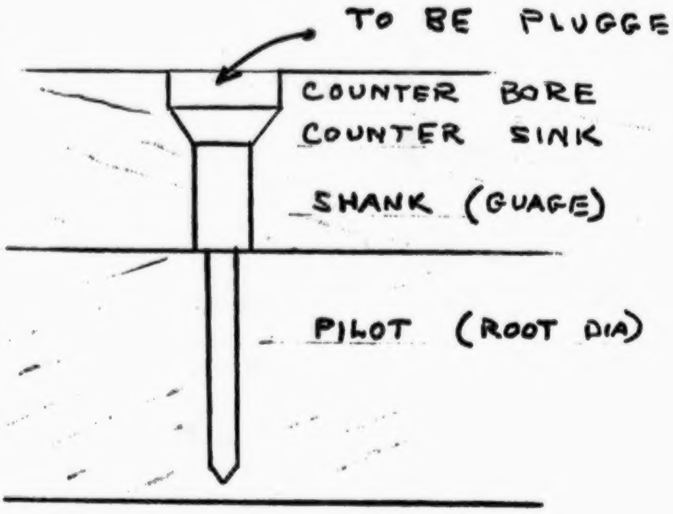

TO BE PLUGGED
COUNTER BORE
COUNTER SINK
SHANK (GUAGE)
PILOT (ROOT DIA)

FIG. 224

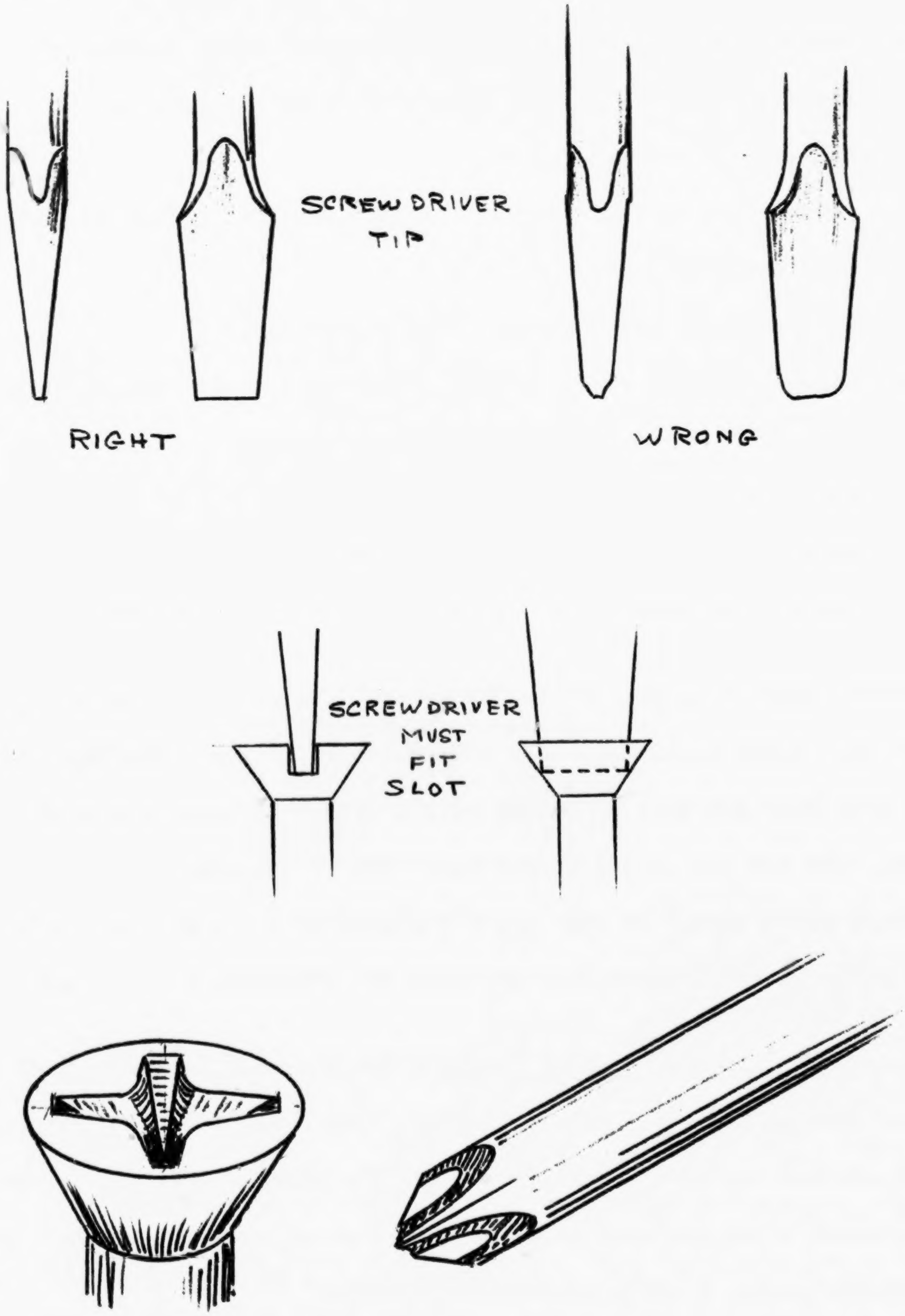

SCREW DRIVER TIP
RIGHT
WRONG
SCREWDRIVER MUST FIT SLOT

FIG. 225

5. Drill a countersunk hole from 1/8 to 1/4" below surface of the first piece of wood. (The size to be the same as the diameter of the head).
6. Counterbore to the depth of the counter sink. (Same as screw head diameter).
7. Select proper screw driver. See figure 225.
8. After inserting screw to full tightness (careful not to strip threads in wood), fill bored hole with putty or plug.
9. Sand and smooth.

Note: Where a round head screw is used, steps #5 and #6 may be eliminated. Where appearance is not paramount, step #6 may be eliminated.

Other types of screws are the lag screw, screw eye, screw hook and cup screw. These screws are used for special purposes. The lag screw has a bolt head and must be driven with a wrench instead of a screw driver. (Do not use pliers as the head will be damaged.)

Pilot holes should be used for all wood screws, as this not only makes them easier to drive, but prevents the splitting of the wood.

i. Corner irons and corner brackets are the most common type of special joining devices. See figure 226. One needs only to glance in a well stocked hardware department to see the wide variety of such items. Brackets and irons are used to strengthen corners and butt joints. Where the bracket shows, a fancy type should be used.

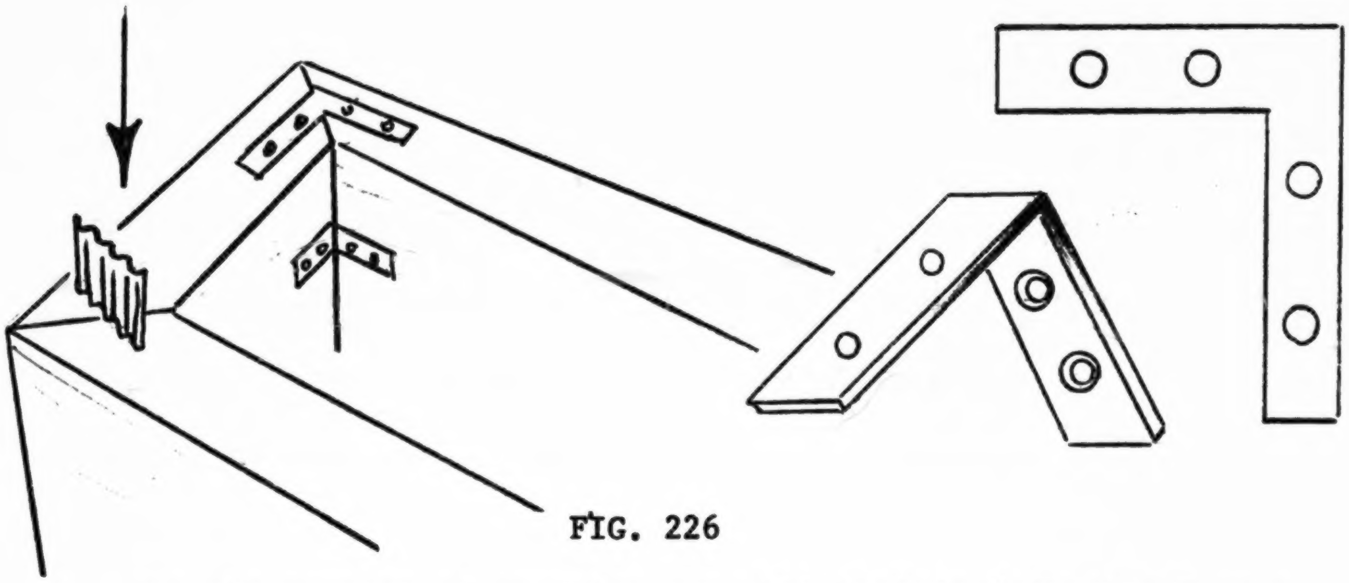


FIG. 226

j. For the purpose of grouping, we will include "adhesives" as a fastener of materials. An adhesive is glue, cement, or mucilage. The selection of an adhesive may appear to be a very simple operation, however, there are some very important considerations.

1. What materials are to be joined? Wood is porus; more porus on end grain.
2. How much gap is left between the joint? Some adhesives require a gap, others do not. Some joints have to be slotted to create an open space for the adhesive.
3. Some adhesives "set" or dry fast, requiring utmost speed in assembly.
4. Some adhesives are slow setting, requiring a clamp arrangement until the joint is permanently set.

Adhesives may be purchased already prepared and mixed, ready to use. Other adhesives require mixing either with water or a prepared catalyst. (Such as some epoxies). Usually a nail or a screw used in conjunction with a glue joint creates the best and most permanent construction. The use of an adhesive is usually limited to fine cabinet or expensive construction.

C. JOB DESCRIPTION AND METHOD:

I. SHELVING: Shelving may be constructed as free standing, wall mounted, floor mounted or ceiling mounted. Obviously the prime considerations should be strength and appearance. Almost all custodians build shelves in their own custodial storerooms and custodial closets to hold cleaning supplies and equipment. Many times shelves are requested in the halls, classrooms, locker room, cafeteria, etc., primarily to hold school books.

FREE STANDING SHELVES

A free standing shelf or shelves means that the construction is a unit that depends upon itself to be stable and true without the aid of a wall. Movable book cases are typical examples of free standing shelves. The principle parts of free standing shelves are:

a. top shelf
b. bottom shelf
c. intermediate shelves
d. sides
e. back
f. feet or legs

Tools needed:

a. crosscut hand saw
b. screw driver
c. carpenters square
d. hand drill and bits
e. hammer
f. nails and screws

Procedure:

1. Determine height, width, depth.
2. Determine how many shelves.
3. Decide whether legs or not. (The two sides and back may act as legs, allow at least 5" from floor to first shelf for cleaning underneath).
4. Sketch simple diagram showing corners and measurements. See figure 227.

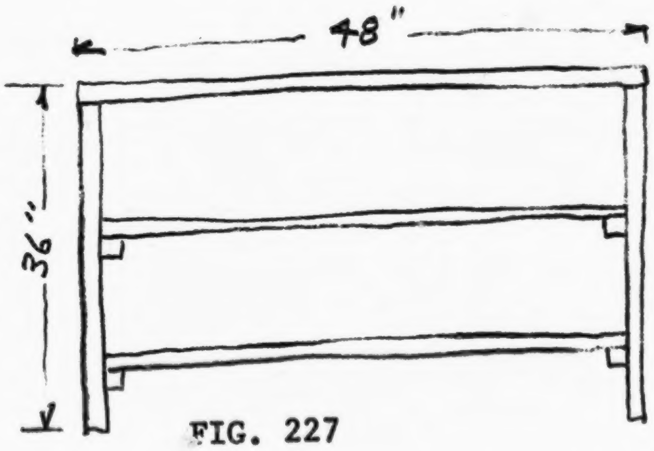


FIG. 227

5. Shelf stock is usually 1" x 12" x 48" (anything over 48" will require additional support to prevent sagging).
6. Square up and saw to size the two sides. (36" less the thickness of the top shelf - 3/4"). One inch stock is finished at 3/4". See figure 228.

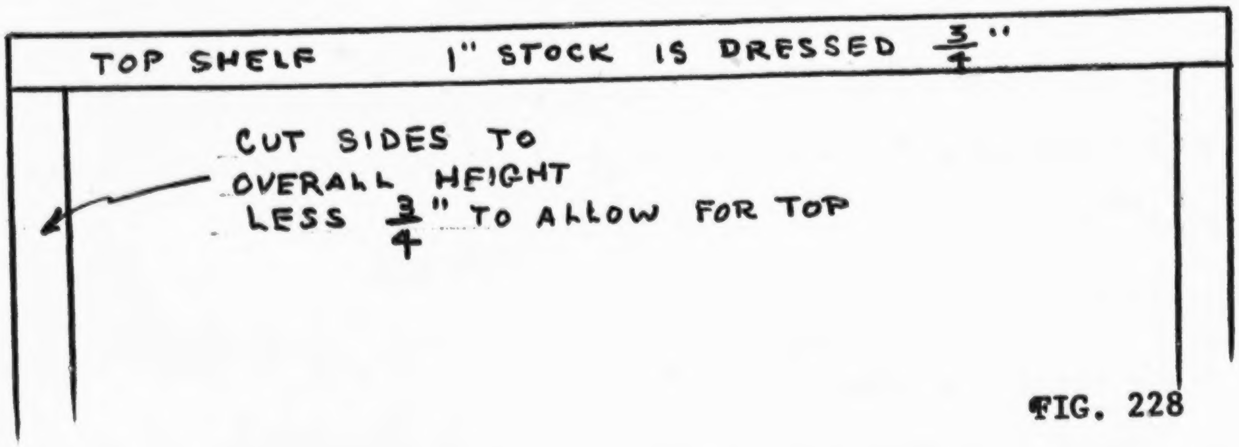

TOP SHELF
1" STOCK IS DRESSED 3/4"
CUT SIDES TO OVERALL HEIGHT LESS 3/4" TO ALLOW FOR TOP

FIG. 228

7. Square up and cut top shelf - 48".

8. Square up and cut bottom and intermediate shelves 36" less the thickness of the two sides - 1 1/2".

9. If blocks are used to support shelves - square up and cut blocks (use quarter round or any suitable strip up to 1" x 1").

10. Shelves may be supported in various ways. See figure 229.

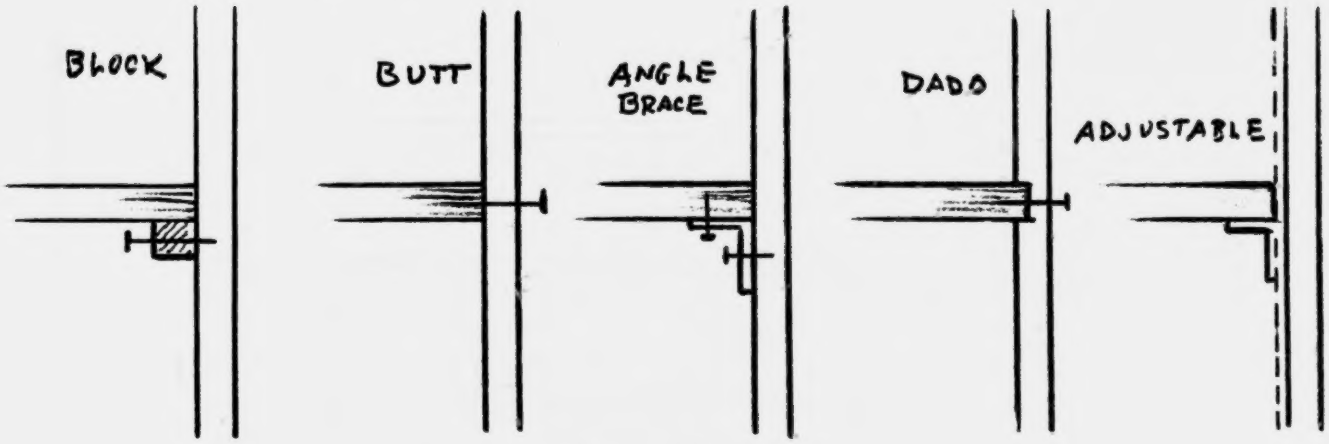


FIG. 229

11. A complete backing of either 1/4 plywood or 1/8 fiber board is used to keep the unit square and also to prevent objects being pushed through the shelves. Square up and cut backing 48" x 36" or the height from lower edge of bottom shelf to top edge of top shelf.

WALL MOUNTED SHELVES

Wall mounted shelves are not as strong as other types therefore a narrower board (1 x 8) should be used to preclude heavy objects being placed on them.

Materials needed:

a. 2 shelf brackets

b. shelf 1" x 8" x 48"

c. Wood screws - 1/2 #8 flat head

d. 2 toggle or molly bolts. See figure 230.

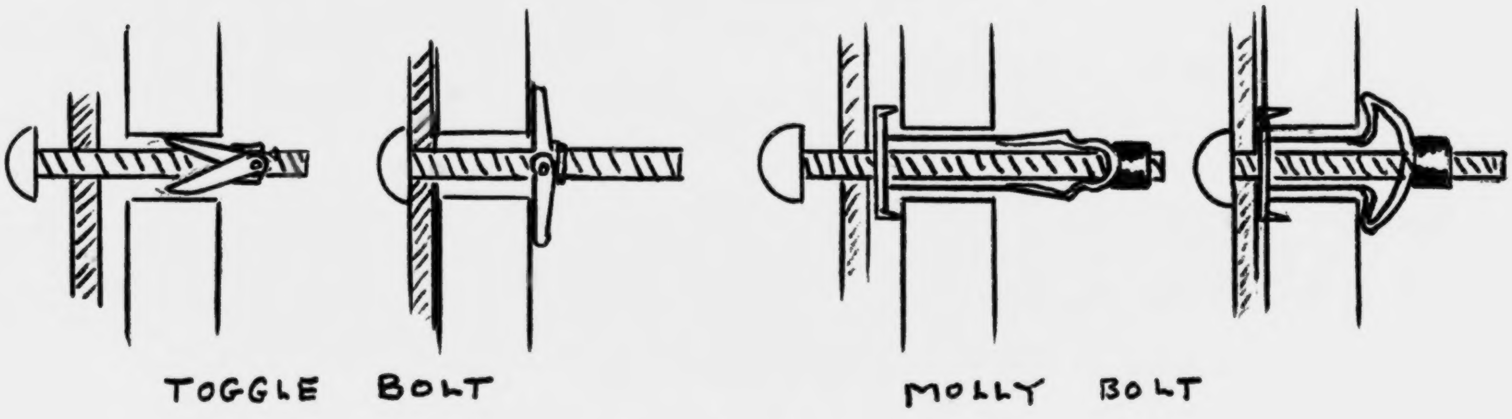


FIG. 230

e. 2-1 1/4, #10 flat head wood screws

f. 2 plastic or lead shields

g. adhesive (optional)

Procedure:

1. The floor is assumed to be level therefore measure up from the floor, the desired height of the shelf and draw a light pencil line (horizontal).
2. Draw another line 3/4" beneath the first line.
3. Hold shelf bracket in position with top against the lower pencil line.
4. With pencil mark both holes on wall.
5. Do the same with second shelf bracket. Allow 6" in from each end. See figure 231.

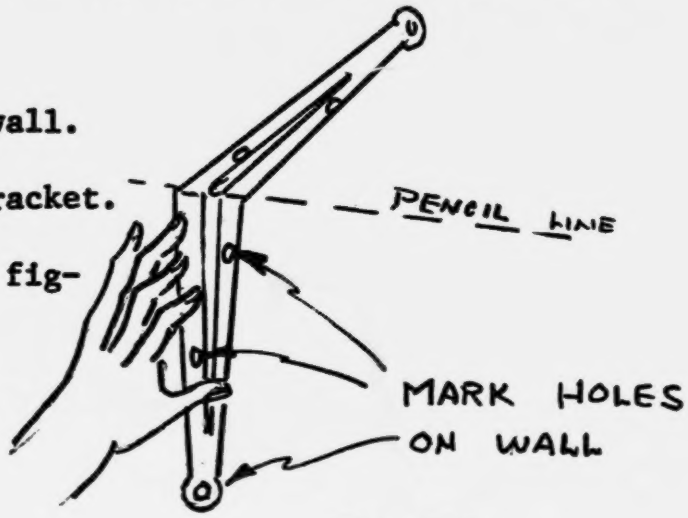


FIG. 231

6. Determine wall construction (hollow or solid).

7. If hollow, drill appropriate size hole through wall to fit toggle or molly.

8. Fasten both shelf brackets by sliding in toggle or molly and tightening firmly with screwdriver.

9. Square up, and cut shelf stock (refinish at this point). See Chapter for wood finishing.

10. Center shelf on brackets and insert wood screws.

Note: If wall is solid, use a lead shield, and drill appropriate hole to fit the shield -- then proceed as directed. See figure 232.

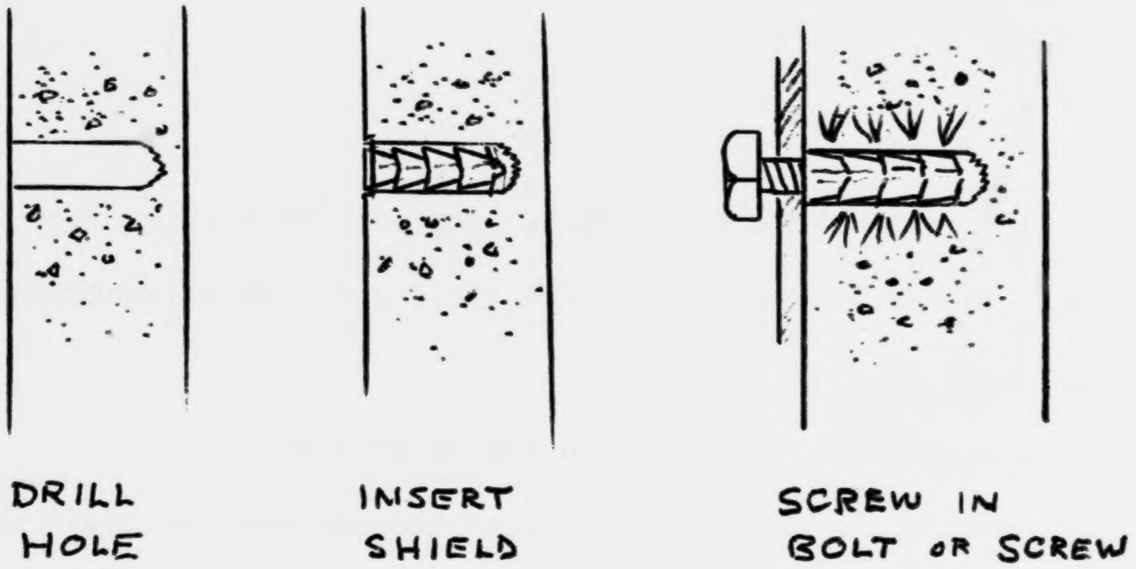


FIG. 232

FLOOR MOUNTED SHELVES

The difference between free standing and floor mounted shelves is primarily that floor mounted shelves depend upon two factors for permanent support:

1. the floor
2. a wall or another permanent vertical structure

Free standing shelves depend upon:

1. the floor only

Wall mounted shelves depend upon

1. the wall only

Materials Needed:

a. vertical supports (may be 1 x 2, 2 x 2, 1 x 6, 8, 10, 12)
b. appropriate shelving (1 x 6, 8, 10, 12)
c. necessary finishing nails or flat head wood screws
d. shelf support strips (optional)
e. wall plate strip or angle irons
f. toggle, molly or shields
g. adhesive (optional)

Procedure:

1. Decide on type of vertical support, size of shelf, and number of shelves, depending upon the use.
2. Determine spacing between shelves.
3. Decide on method of support (for each shelf and on the wall.)
4. If 1 x 2, 2 x 2, or 2 x 4 supports are used:
    a. Cut to length and notch out all four supports at the proper intervals by using a crosscut saw and cutting 1/3 the thickness of the support. See figure 233.

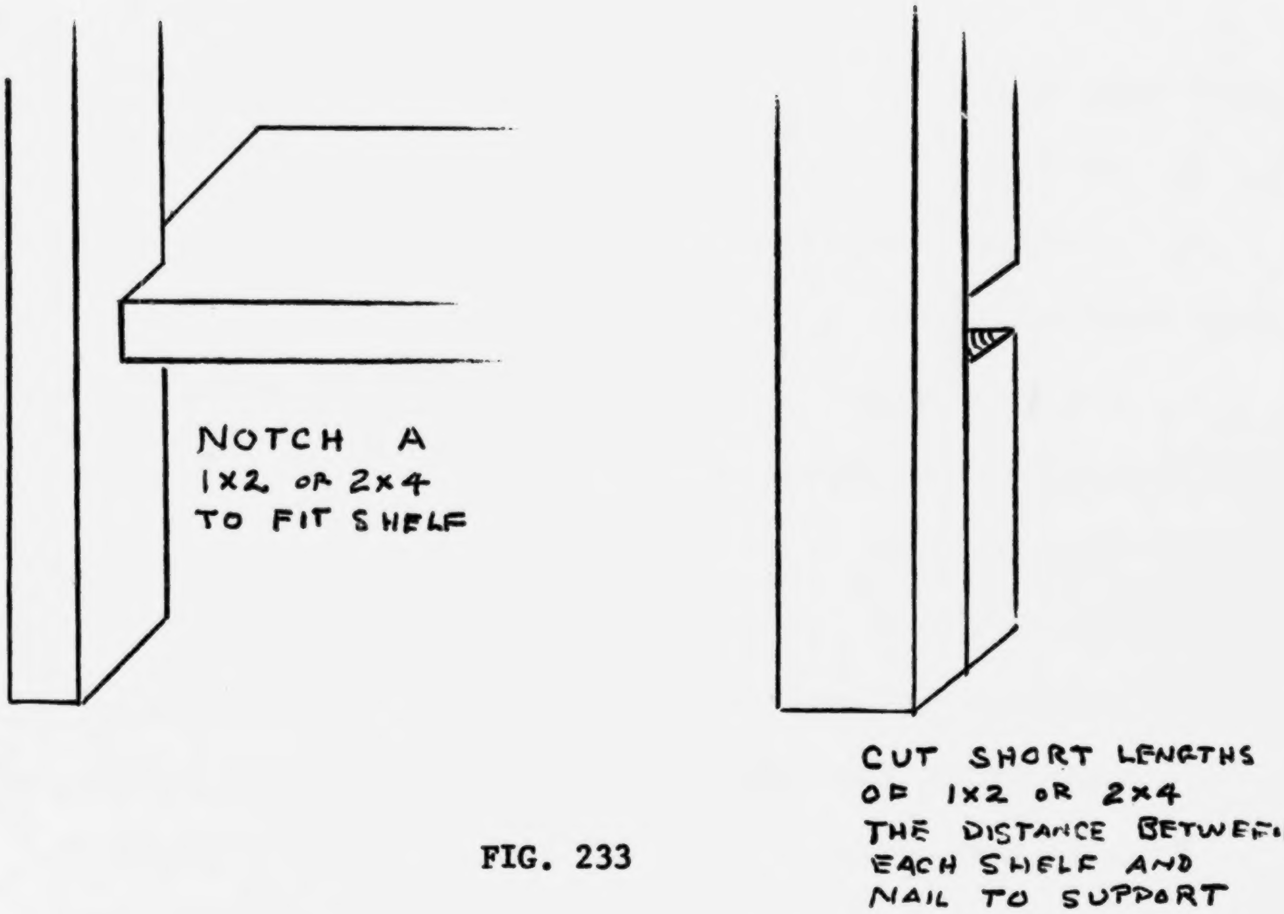

NOTCH A
1X2 OR 2X4
TO FIT SHELF
CUT SHORT LENGTHS
OF 1X2 OR 2X4
THE DISTANCE BETWEEN
EACH SHELF AND
NAIL TO SUPPORT

FIG. 233

b. Square and cut the shelves to length.

c. Fasten each shelf in the four notches provided, by nail or wood screw. Counter sink if desired. See figure 233.

d. Complete assembly for all shelves and stand against wall.

5. If vertical supports are to be 2 solid

   a. Square and cut both end pieces to length.

   b. Measure distances between shelves on both end pieces.

   c. Start finishing nails or drill for wood screws at proper places. See figure 234.

   d. Square and cut shelves to length.

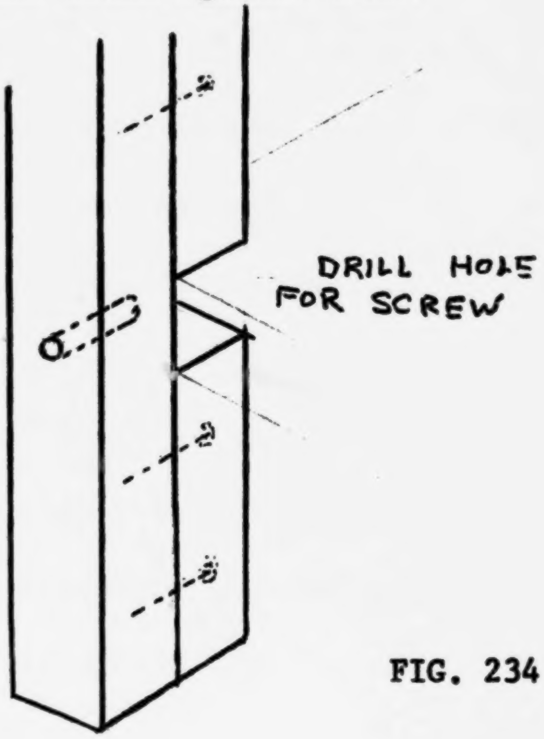

DRILL HOLE
FOR SCREW

FIG. 234

   e. Fasten each shelf to end supports.
   f. Add shelf support strips if desired.
   g. Assemble all shelves.
   h. Stand against wall.

6. In order to achieve stability the shelf unit must be supported by the wall.
   a. Cut a wall strip to proper length.
   b. Make sure unit is plumb. See figure 235.
   c. While holding strip against the wall immediately underneath top shelf draw a light pencil line on wall.
   d. Prepare wall for strip by drilling proper hole for 2 toggles, mollys or shields.

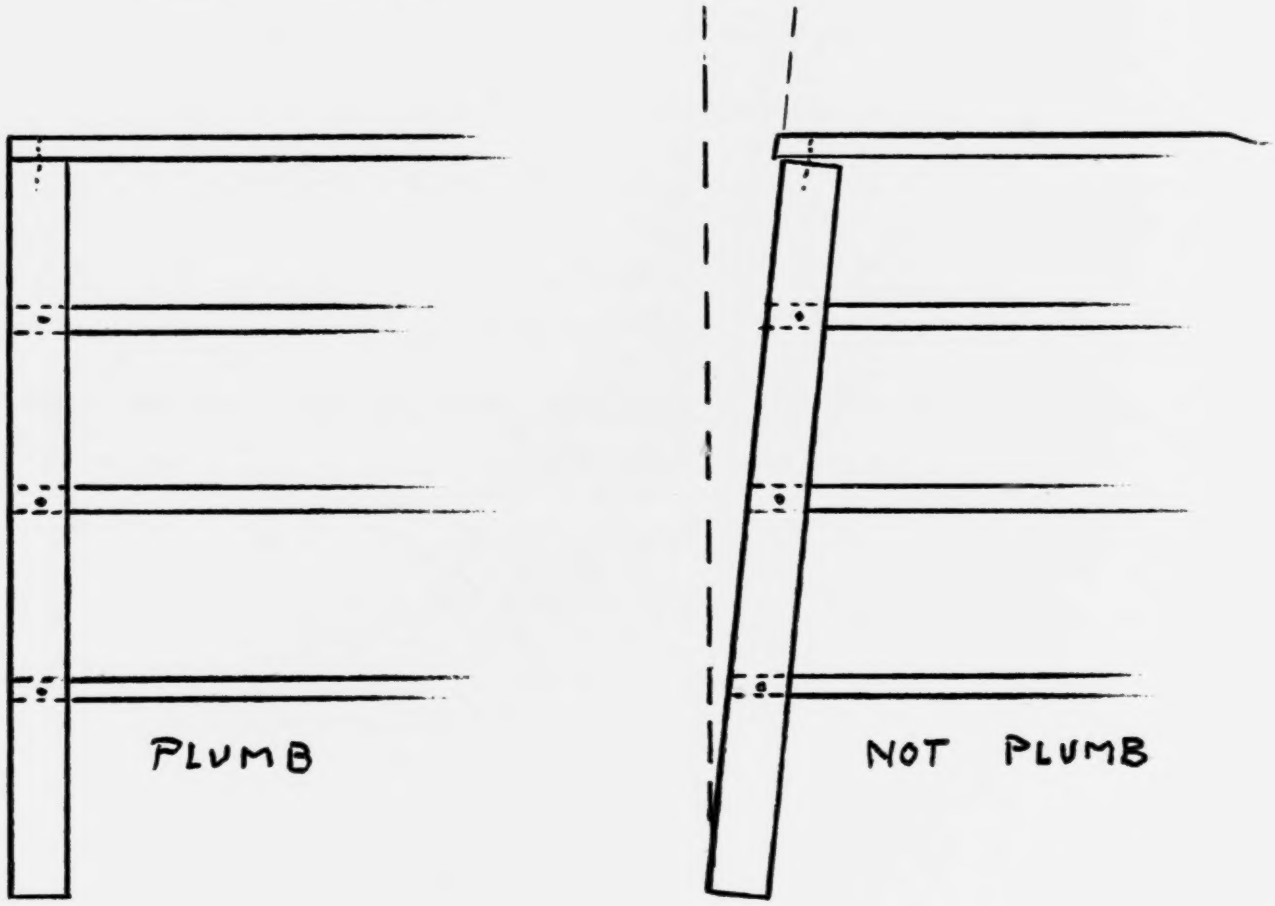


FIG. 235

e. Fasten strip to wall.

f. Secure top shelf to strip by nails, screws or 2 angle irons.

Note: Adhesive may be used at all shelf joints along with nails or screws.

II. FURNITURE REPAIR (wood): School furniture, although constructed rather sturdy, is sometimes in need of repair. When we speak of repair, we mean replacing or re-securing broken members or parts, and then refinishing the surface. To determine whether the custodian tackles such a job depends upon, policy and severity of the damage.

The type of furniture repair usually encountered is listed:

1. Broken rungs or stools or chairs.
2. Broken or cracked wooden seats.
3. Broken legs on tables, chairs or stools.
4. Loose joints on corners, drawers, rungs, legs.
5. Peeling veneers.

Again for the purpose of "Minor Maintenance", the procedures that follow will refer only to repair rather than replace (fashion or construct a new member).

LOOSE JOINTS

Factory made joints are usually glued and may have nails or screws added for strength.

Procedure:

1. If possible, remove the member completely from its socket; or separate if it is a corner.

2. Completely clean the joint or socket. Note: If socket is enlarged and the wood is deteriorated, a tight, strengthened socket will have to be created.
3. Examine the joint or socket carefully, and use plastic wood or shims to repair splintered areas.
4. If screw holes have been stripped, make new holes as close as possible or fill the old ones. See figure 236.

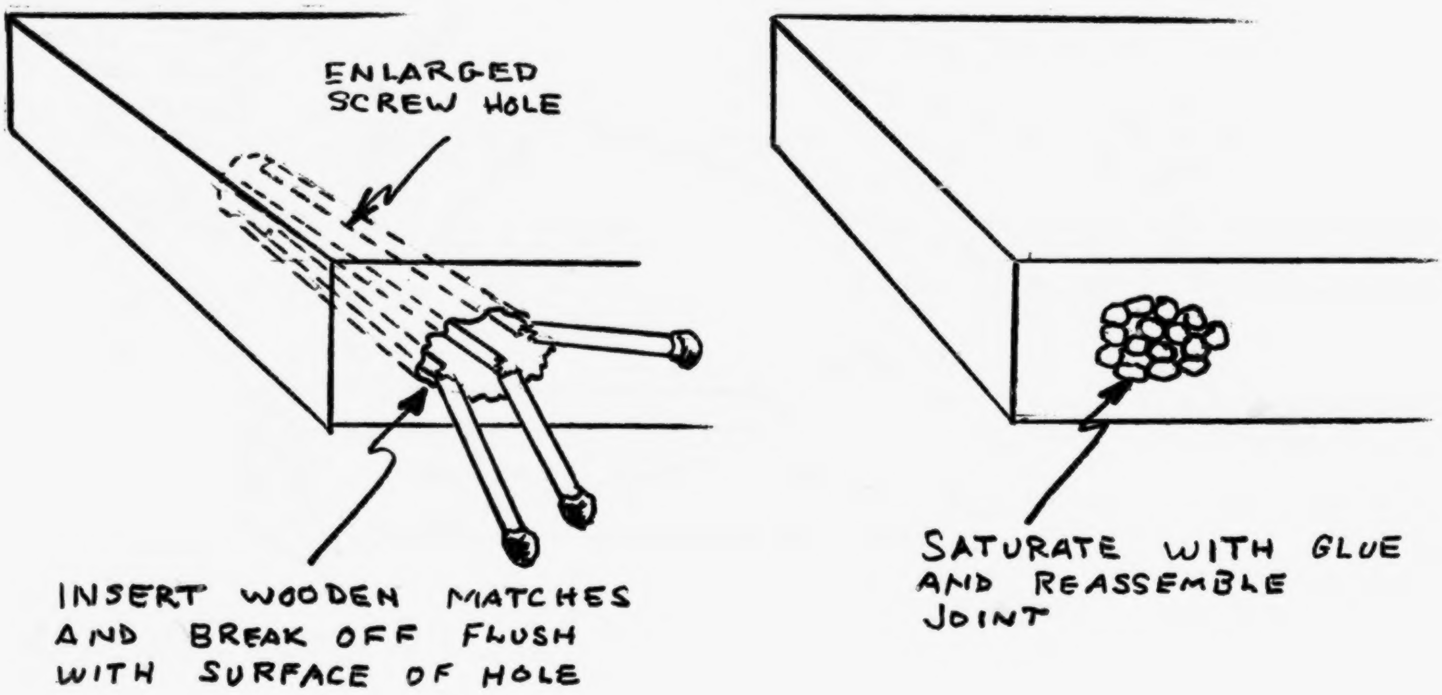

ENLARGED SCREW HOLE
INSERT WOODEN MATCHES AND BREAK OFF FLUSH WITH SURFACE OF HOLE
SATURATE WITH GLUE AND REASSEMBLE JOINT

FIG. 236

5. Apply adhesive to joint and reassemble members.
6. Reinsert screws or nails if necessary. (longer screws may be advisable)

7. Devise a clamp arrangement to hold members together until adhesive is set. See figure 237.

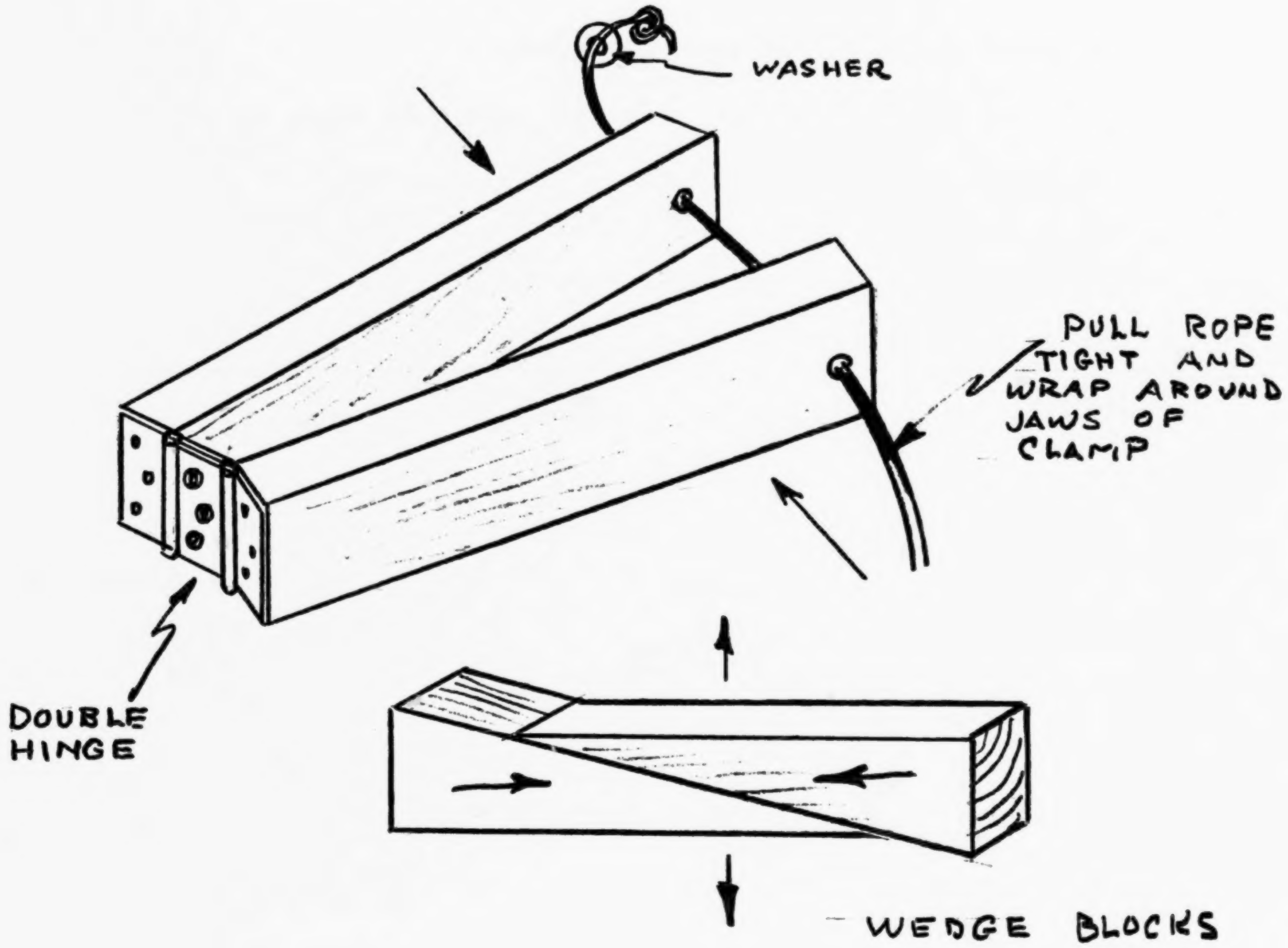

WASHER
PULL ROPE TIGHT AND WRAP AROUND JAWS OF CLAMP
DOUBLE HINGE
WEDGE BLOCKS

FIG. 237

CRACKED, FRACTURED OR BROKEN MEMBERS

Whether the broken or splintered section can be repaired depends upon the type of break and its location.

If the broken member is a support piece it may not be advisable to repair it.

If the broken member is a decorative piece that has no structural significance then it may be highly advisable to repair it. There are various kinds of breaks and each requires definite analysis before attempting to do a repair. See figure 238.

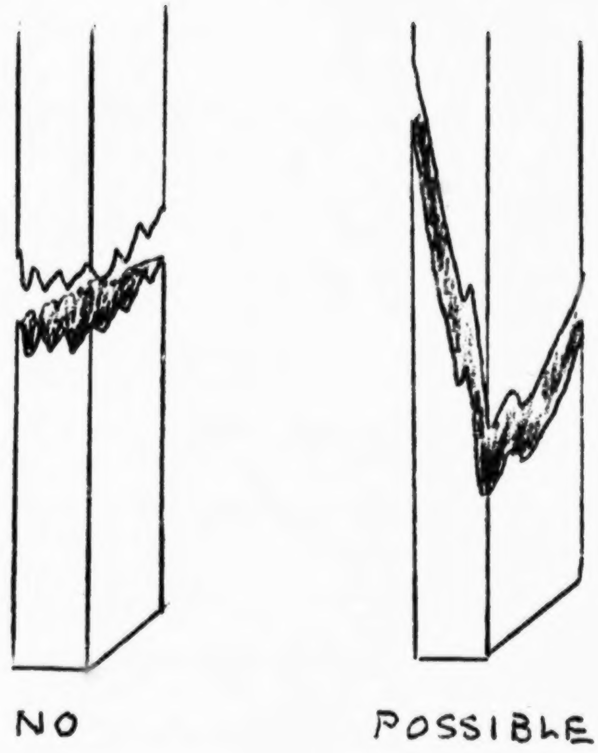


FIG. 238

Most school furniture is purchased in quantity and over a period of years a few pieces may have been rendered useless. Some schools have a storage area where extra rungs, legs, etc. are available for replacement parts. Where the parts are identical, replacement can be made, which proves highly satisfactory.

III. WINDOW GLAZING AND REPLACEMENT: Cracked or broken window glass enjoys probably the highest rate of incidence over any other single accident or vandalism problem. Aside from the appearance aspect, there is a safety factor involved.

Broken glass in windows, doors, or showcases must receive immediate attention by the custodian, even if the county policy dictates that the Maintenance Department must make the repair. At the very least, the custodian should sweep the broken glass, remove all loose glass in the lite, and cover all raw edges. It is advisable to wear gloves during this operation.

REMOVAL OF BROKEN PANE

Procedure:

1. Start at top of lite and remove putty with a knife. See figure 239.
2. Remove glazing points if used.
3. As soon as upper sections of the broken glass are free of putty and points, remove the glass and place in a container. Continue until all glass is removed.
4. As the glass is being removed, grip each piece well with a glove.
5. Small pieces and slivers can be handled with parallel jaw pliers by attaching a small piece of masking tape to the pieces to be removed. See figure 240.
6. The sash should be cleaned of all old putty and points.

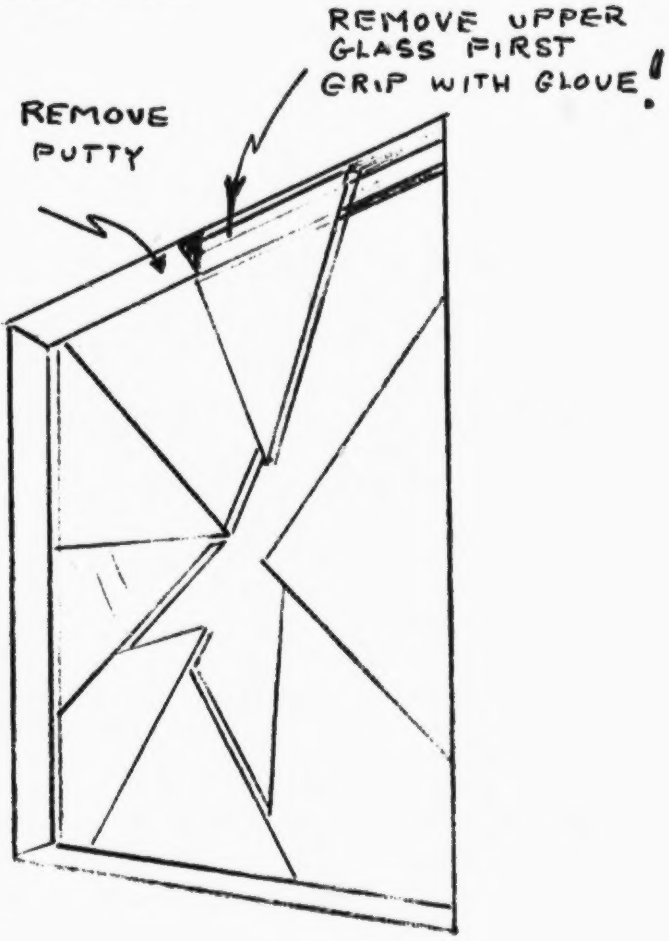

REMOVE UPPER GLASS FIRST GRIP WITH GLOVE!
REMOVE PUTTY

FIG. 239

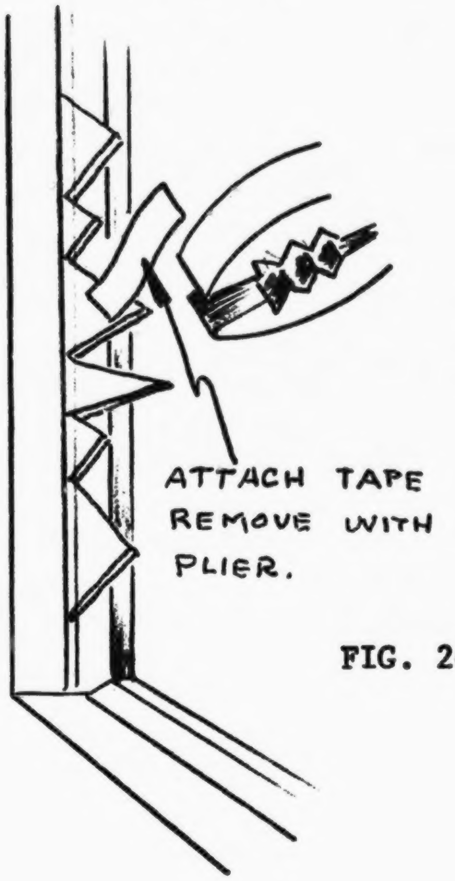

ATTACH TAPE REMOVE WITH PLIER.

FIG. 240

7. The opening may now be covered by inserting (to size) plywood, hardboard, cardboard, or any other suitable material to protect the interior from the elements.

REPLACEMENT WITH NEW GLASS

Procedure:

1. Measure opening -- height and width.
2. Select matching glass (strength, etc.)
3. Cut glass 1/8" under the measured opening.
4. Lay in a bead of back putty around the perimeter of the opening. See figure 241.
5. Insert new glass and press into bead, forming a seal between the wood and the glass.
6. Insert glazing points. See figure 242.

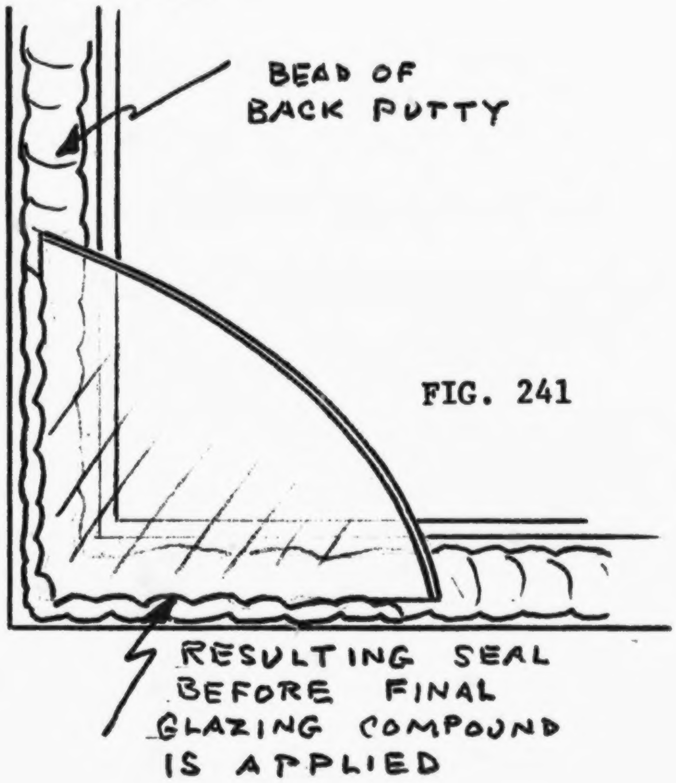

BEAD OF BACK PUTTY
RESULTING SEAL BEFORE FINAL GLAZING COMPOUND IS APPLIED

FIG. 241

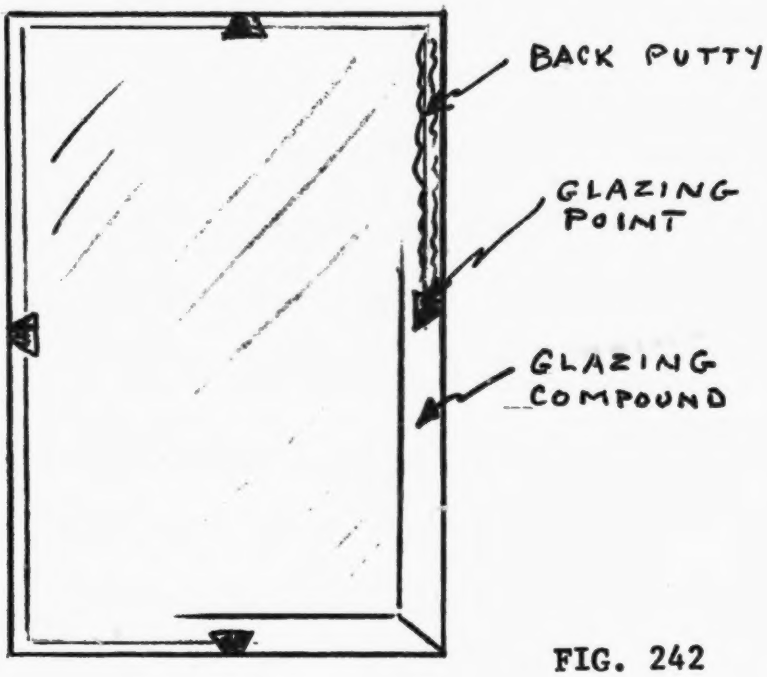

BACK PUTTY
GLAZING POINT
GLAZING COMPOUND

FIG. 242

7. Lay in a bead of glazing compound and trim with putty knife. The putty should not be thicker than the interior wood sash frame. See figure 243.
8. Clean glass both sides.
9. Prime and paint the new putty to prevent drying and cracking.

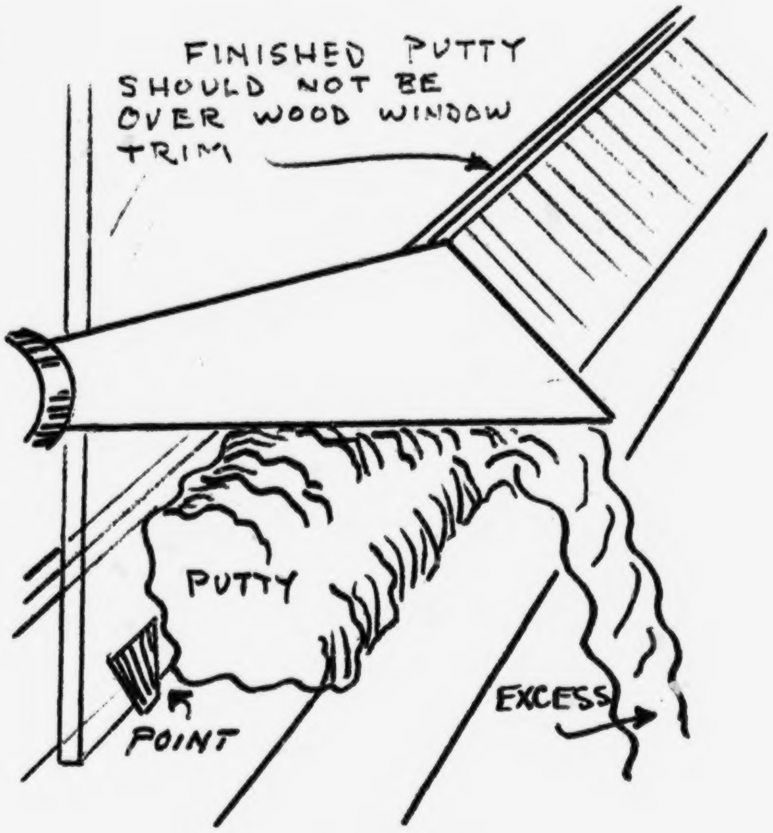


FIG. 243

GLASS CUTTING

Procedure:

1. Select a level surface to work on.
2. Lay down several thicknesses of newspaper (smooth-no wrinkles).
3. If a large piece of wrapping paper is available, place it over the newspapers.
4. Using a framing square, draw the exact size of the glass.
5. "Square up", two sides of the glass over the diagram.
6. With a rag or brush wet the surface of the glass over the line to be cut with mineral spirits.
7. Using a straight edge, firmly held against the glass, "SCORE" the upper edge about 1/4" with the glass cutter. See figure 244.

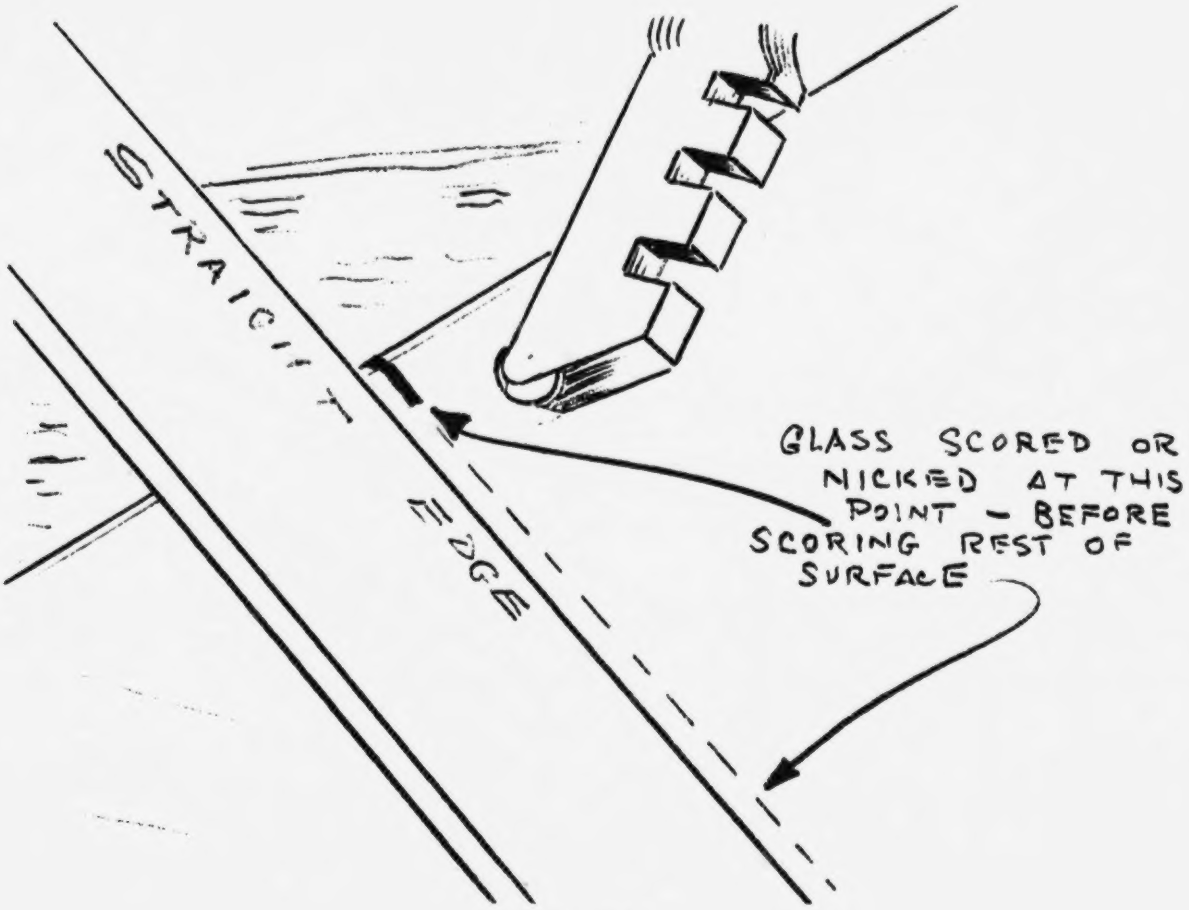

STRAIGHT EDGE
GLASS SCORED OR NICKED AT THIS POINT - BEFORE SCORING REST OF SURFACE

FIG. 244

8. Holding the glass cutter firmly against the straight edge and over the line, using even firm pressure, draw the cutter down along the edge in one continous stroke, until off the glass. (Do not score back and forth, or try to go over the line again.)
9. Slide the glass over the edge of table -- Grip the unwanted portion with a glove hand applying a slight downward pressure-- smartly tap the underside directly under the score with the ball on the handle of the glass cutter. See figure 245.

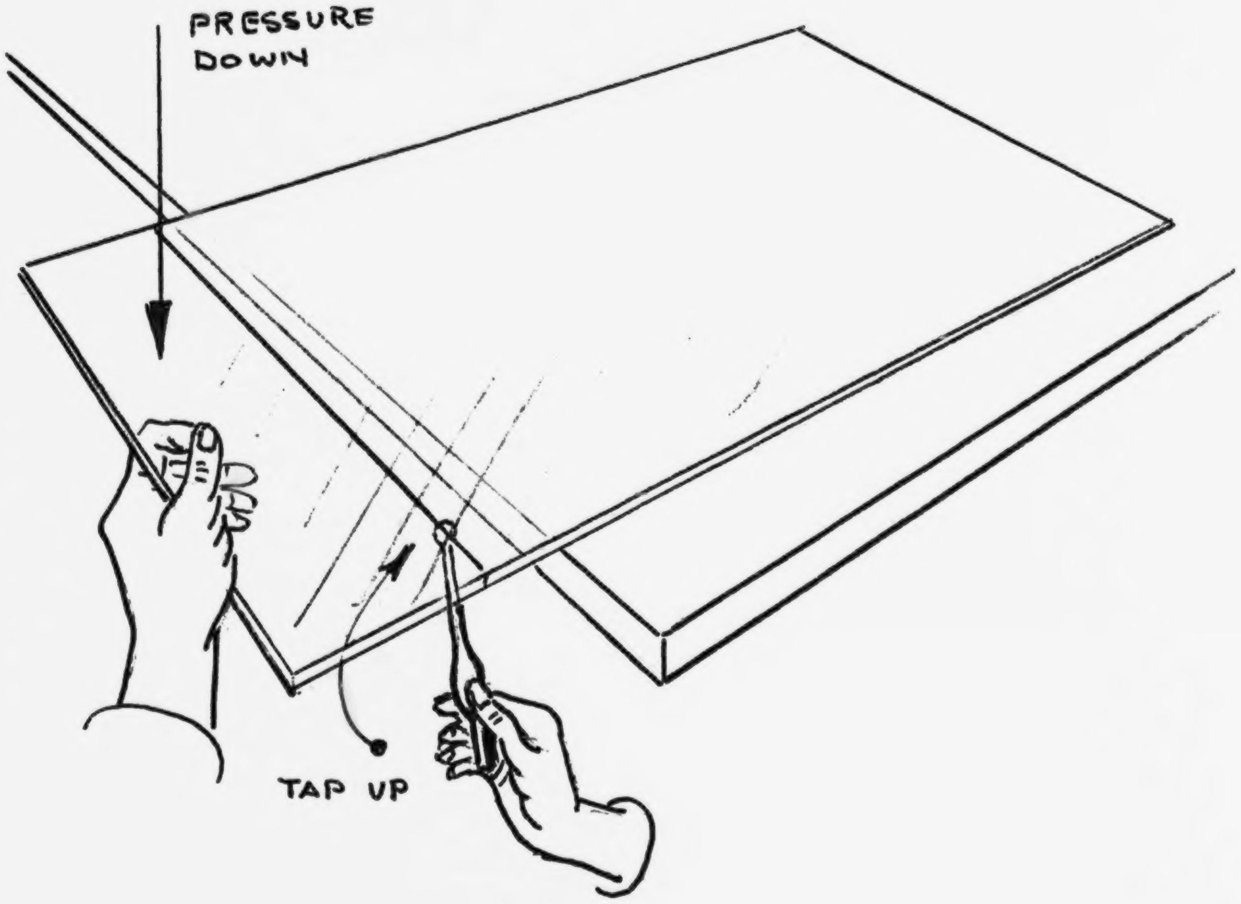


FIG. 245

10. Glass should split along the scored line, without irregularities. See figure 246.

    Note: If the glass splits in a curve off the line, repeat step 9 from opposite end. Glass will now have a irregularity as in figure 247. Use the notches in the glass cutter to chip off the unwanted portions. Take precautions against flying chips.

    Extra Note: Glass that has been inaccurately measured and cut slightly overside, is Extremely Difficult to trim and should not be attempted.

11. After the glass has been cut, the sharp edge should be either filed with a fine file or abrased with emory cloth.

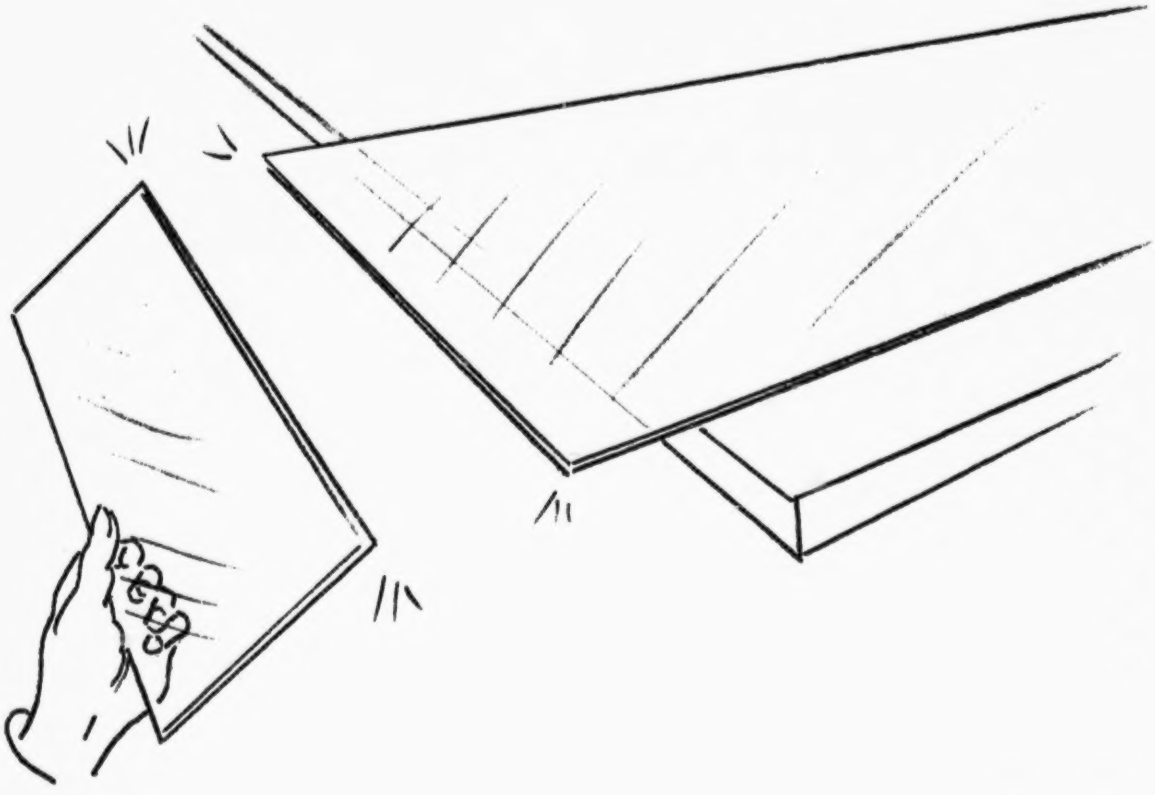


FIG. 246

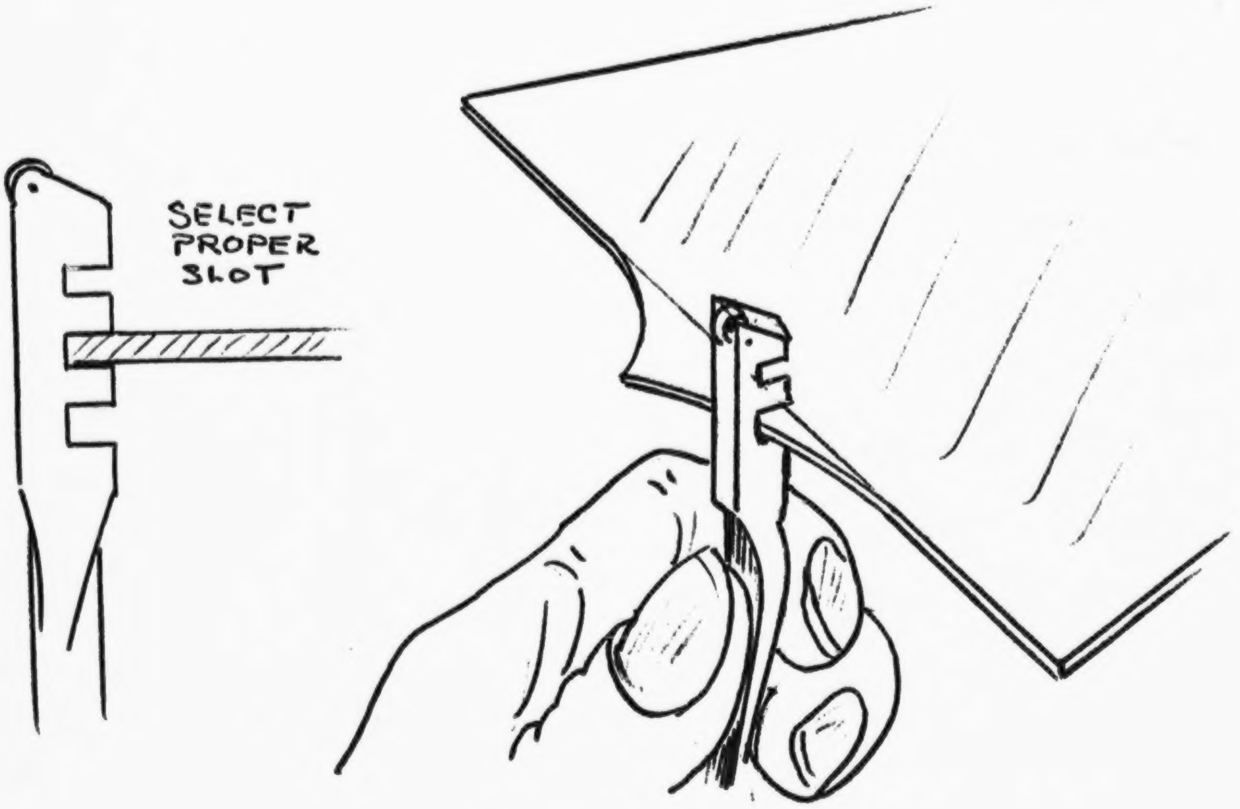

SELECT
PROPER
SLOT

FIG. 247

IV. WINDOWS

To repair a venetian blind.

The principle parts of a venetian blind are:

1. Header or top rail
2. Bottom rail
3. Slats
4. Cord (tilting & raising)
5. Tape
6. Cord lock
7. Tilter

The header contains the hardware i.e., pullies, tilting mechanism, and cord lock. See figure 248.

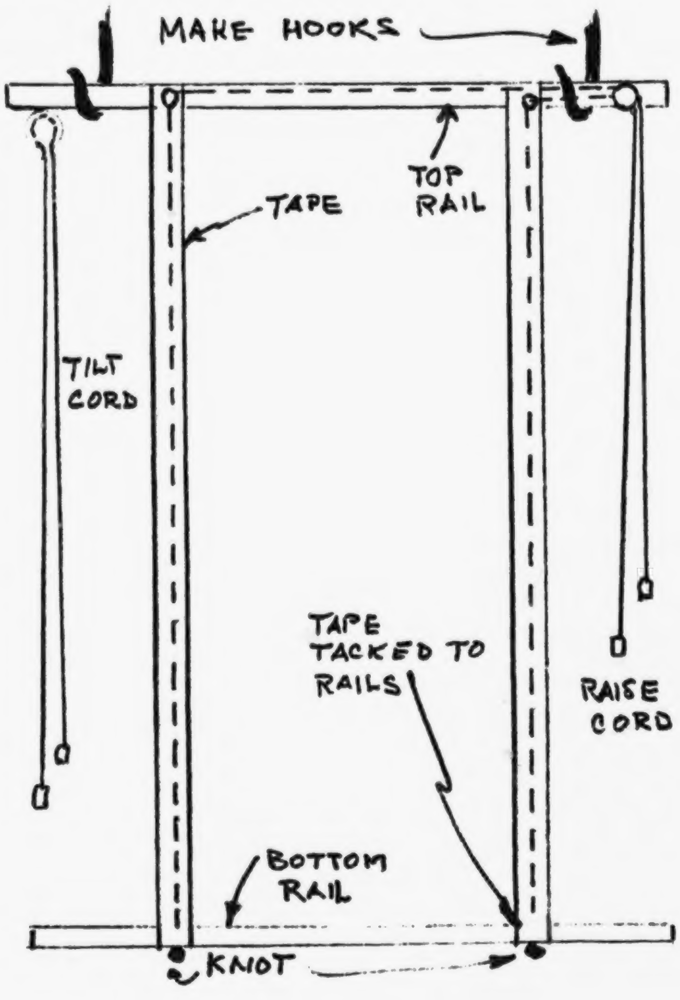

MAKE HOOKS
TOP RAIL
TAPE
TILT CORD
TAPE TACKED TO RAILS
RAISE CORD
BOTTOM RAIL
KNOT

FIG. 248

Procedure (To replace all or part)

1. Remove blind from window.
2. Hang blind (fully extended) by looping around extreme ends of header. (Two hooks with loops attached can be pre arranged in the custodial room.)
3. Untie knots in cord at bottom rail.
4. Pull old raising cord completely out of blind.
5. Remove slats.
6. Remove tape (usually stapled to top and bottom rail).

7. Check pullies & remove tilting cord.

8. Clean all parts i.e., slats, rails etc.

9. Cut new tape to exact length of window so that when blind is installed and extended the bottom rail is about 1/4" above sill.

10. Retack new tape to both rails.

11. Replace cleaned slats, one on each loop.

12. Cut new raising cord 4 x the length of the blind, plus (1) width.

13. Thread new cord through lock, pullies and slats and knot under bottom rail.

14. Cut new tilting cord (1 3/4) x the length of the blind and install through tilting mechanism.

15. Check workings before installing in window.

16. Pull cord should be knotted about 3/4 way up the blind to enable even raising of both sides.

To repair cord & weight in double or single hung windows.

A double hung window is one in which both the upper half and the lower half can be raised or lowered. In a single hung window, the lower half only is able to be raised.

Procedure

1. Remove the inside stop on both sides (careful not to destroy the wood, otherwise replacement may be necessary).

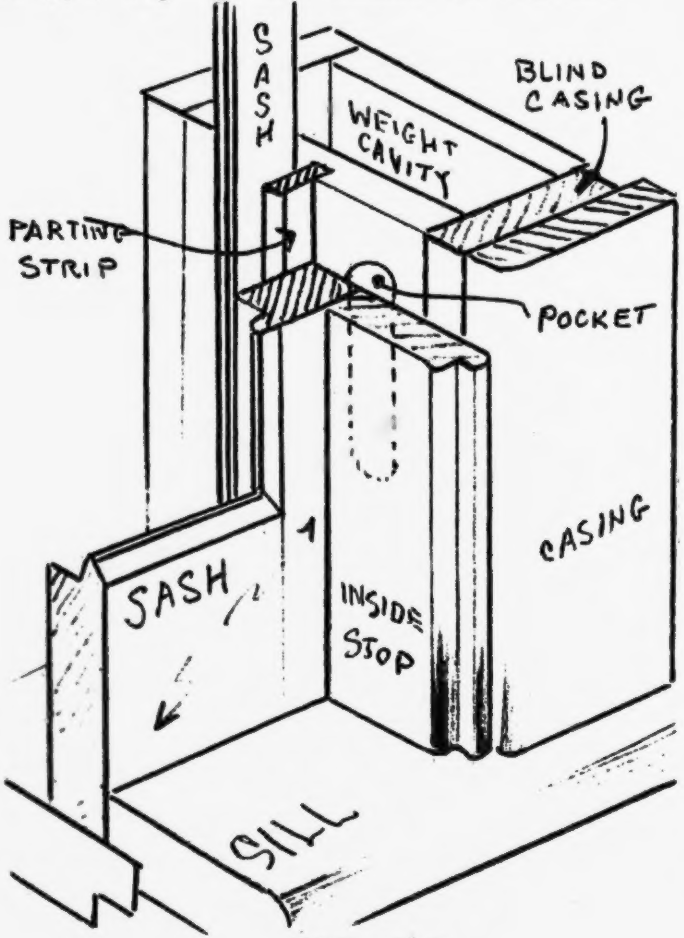


FIG. 249

2. In some cases the parting strip will also have to be removed.

3. Slide window out and remove the chain or cord fastened to the sash on either side.

4. Remove the pocket. (If there is no pocket, the inside trim and blind casing will have to be removed to expose the weights.) See figure 249.

5. Unfasten the old cord or chain from the weights.

6. Cut new cord the same length as the old one.

7. Thread cord through pulley by using a string & weight first, then pull the cord through.

8. Fasten new cord to both weights and window sash.

9. Replace casings or pockets.

10. Reset window.

11. Check movement of window.

12. Reinstall inside stop.

13. Bar soap rubbed on edges of sash can prevent binding.

CHAPTER III
PLUMBING

PLUMBING DEFINITIONS

ADJUSTABLE PIPE HANGER - A pipe hanger consisting of a beam clamp, an adjustable rod, and an adjustable ring.

AIR ESCAPE - A contrivance for discharging excess air from a water pipe. It consists of a ball cock which opens the discharging air valve when sufficient air has collected and closes it in time to prevent loss of water.

AIR TRAP - A water-sealed trap which prevents foul air or foul odors from rising from sinks, wash basins, drain pipes, and sewers.

BACK FLOW - The flow of water or sewage in the direction opposite to its normal flow.

BACK FLOW VALVE - A contrivance inserted in the drain of a house or other building to prevent a reversal of the flow of sewage. Its chief function is to prevent a flood and the resulting damage which might be caused by the overflowing of a combination type of public sewerage.

BACK PRESSURE - Air pressure in pipes when it is greater than the atmospheric pressure.

BACK VENT - A pipe for ventilating purposes, attached to a waste pipe on the sewer side of its trap to prevent siphonage of waste or superfluous fluid.

BACKWATER FLAP - A type of valve in which back flow of a liquid is prevented by a hinged metal flap fitted in an intercepting chamber, so as to allow the flow of water in one direction only.

BACKWATER VALVE - An automatic valve placed in the sewer lateral, to keep sewage from backing into the basement or into plumbing fixtures during times of heavy rains and flood periods.

BALL COCK - A self-regulating faucet which is opened or closed by the rising and falling of a hollow ball floating on the surface of the water.

BALL VALVE - A type of water valve which regulates the flow of water in a tank by means of a floating ball; this ball fits on the end of a lever, and by its rise and fall, due to suction and its own weight, allows water to flow, then shuts it off when it reaches a certain height.

BELL-AND-SPIGOT JOINT - A common type of joint for cast-iron pipes, each length of pipe being made with an enlarged or bell end and a plain or spigot end; the spigot end of one length fitting into the bell end of the next length, the joint being tight by calking. Sometimes called spigot-and-socket joint.

BIB - A faucet or tap. A water faucet threaded so a hose may be attached to carry water. Also spelled bibb.

BIBCOCK - A faucet fitted with a nozzle curving downward, used as a draw-off tap.

BIB NOZZLE - A faucet or stopcock bent or curved downward.

BIB VALVE - A draw-off tap of the type used for a domestic water supply. It is closed by the screwing down of a leather-washered disc onto a seating in the valve body.

BULLHEAD TEE - A tee with a branch longer than the run; also, one having an outlet larger than the opening on the run.

CALIDUCT - A pipe for conveying hot air, hot water, or steam for heating purposes.

CALKING TOOL - A tool used for driving tarred oakum, cotton, and other materials into seams and crevices to make joints watertight and airtight. The calking tool is made of steel and in appearance somewhat resembles a chisel.

CALK JOINT - A joint packed with oakum and finished with molten lead.

CAST-IRON PIPES - Pipes made of cast-iron to meet the various requirements of a sewerage or drainage system.

CATCH BASIN - A cistern, or depression, at the point where a gutter discharges into a sewer to catch any object which would not readily pass through the sewers; a reservoir to catch and retain surface drainage; a receptacle at an opening into a sewer to retain any matter which would not easily pass through the sewer; a trap to catch and hold fats, grease, and oil from kitchen sinks to prevent them from passing into the sewer.

CESSPOOL - A pit or cistern in a drain for the reception or detention of sewage. Also, a small square wooden box, lined with lead, which serves as a cistern in the gutter of a parapet at a point where the roof water is discharged into a down pipe.

CHECK VALVE - A valve preventing the backflow of water or other liquid by automatically closing.

CLEANOUT - A unit with removable plate or plug affording access into plumbing or other drainage pipes for cleaning out extraneous material.

CLEANOUT FOR HOUSE DRAIN - A branch pipe which leads from the main drain pipe through the floor of a building. The clean-out pipe is equipped with a removable brass cover, making access to the main pipe possible when it becomes necessary to remove waste material which clogs the system.

CLOSE NIPPLE - A nipple twice as long as standard pipe thread, with no shoulder between the two sets of threads.

COCK - A type of valve with an opening to permit the passage of liquids, a faucet or tap, as over a kitchen sink.

COLLECTION LINE - That part of a plumbing system which receives the discharge of all soil and waste stacks within the building and conveys it to the house sewer. It may be installed under ground or it may be suspended from the basement ceiling.

CONDENSATION PUMP - In fitting steam pipes, a device for removing liquid condensation from steam returns.

CONDUCTOR - A pipe for conveying rain water from the roof gutter to the drain pipe. Also called leader, downspout, or down pipe.

CORPORATION COCK - A device installed to serve as a control stop for the city-water service, when the main is tapped without shutting off the city-water supply.

CORROSION - The oxidation, or rusting, of metals caused by contact and chemical union with oxygen in a damp atmosphere.

COUPLING - A short collar, with only inside threads at each end, for receiving the ends of two pipes which are to be fitted and joined together.

CUP JOINT - A socket joint formed between two small pipes in the same line, by opening out the end of one pipe to receive the tapered end of the other. The joint is then made firm by filling the space surrounding the lapped ends with moulten solder.

CURB BOX - A contrivance which usually consists of a tube-like casing or a long piece of pipe, placed over a curb cock, through which a key is inserted to permit the turning of the curb cock.

CURB COCK - A control stop installed in a water-service pipe between the curb and the sidewalk. Such a device makes it possible to shut off the water supply from a building if it is to be closed for any reason, or in time of an emergency, such as a flood.

DEAD END - The extended portion of a pipe between a closed end and the connection nearest to it, forming a dead pocket in which there is no circulation, hence permitting the stagnation of water or air contained in the extended and closed end of the pipe.

DEEP-SEAL TRAP - A waterseal trap which has twice the depth of a common-seal trap. The deep-seal trap, having a water column of four inches in depth, is used ordinarily for only abnormal conditions.

DISTRIBUTION TILE - Concrete or clay tile without bell mouths. These tile are laid with a little space at each joint, in lines which fan out from a septic tank distribution box.

DOG-EARED FOLD - A folding joint formed at the corner of sheet lead tray.

DOWN PIPE - A spout or pipe, usually vertical, to carry rain water from a roof to the drain.

DRAIN - Any pipe, channel, or trench by means of which waste water or other liquid is carried off, as to a sewer pipe.

DRAIN COCK - A small valve placed at a low point in a pipe line to allow for draining.

DRAINTILE RECEPTOR - A device consisting of a P trap of deep seal, into which an ordinary cast-iron tee is calked. The top opening of the tee may be provided with either a clean-out plug or a floor-drain strainer.

DRIFT PLUG - A wooden plug driven through a lead pipe to straighten out a kink.

DROP ELBOW - An elbow used for joining pipes, having one or two ears or lugs for attachement to a wall; also, a small ell frequently used where gas is put into a building. Such fittings have wings cut on each side to permit fastening to a wall or framing timbers.

DROP TEE or T - A small tee piece which has the same type of wings as a drop elbow.

ELBOW - In pipe work of any kind, a short fitting connecting two pipes at a right angle. Also called ell.

FLASHING - Piece of lead, tin, or sheet metal--either copper or galvanized iron--used around dormers, chimneys, or any rising projection, such as window heads, cornices, and angles between different members or any place where there is danger of leakage from rain water or snow. These metal pieces are worked in with the shingles of the roof or other construction materials used.

FLOAT VALVE - A valve consisting of a hollow ball floating on the surface of water, shutting off the supply at the intake, as in a toilet tank.

FLOOR DRAIN - A plumbing fixture used to drain water from floors into the plumbing system. Such drains are usually located in the showers, restrooms, and near the furnace and are fitted with a deep seal trap.

FLUSH VALVE - A valve by means of which a fixture is flushed by using water directly from the water-supply pipes or in connection with a special flush tank.

FULLER'S FAUCET - A faucet in which a rubber ball is forced into the opening to stop the flow of water.

GALVANIZED IRON - Sheet iron which is protected against rust by a coating of zinc.

GASKET - Plaited hemp or cotton yarn wound around the spigot end of a pipe at a joint. The hemp or cotton is forced into the socket of the mating pipe to form a tight joint.

GAS PLIERS - Stout pliers having narrow jaws whose gripping faces are concave with the edges notched like teeth; to provide a secure grip on small pipe or round objects.

GATE VALVE - A valve consisting of a brass casting into which is fitted a brass gate. The gate is lifted and lowered by means of a screw stem which is operated by a cast-iron wheel handle. A slight pressure of the hand turns the handle.

GLOBE VALVE - A kind of valve in which a disk which is operated by a screw and hand wheel seats on a circular opening; so installed that pressure is applied on the underside of the seat.

GRAVITY WATER SYSTEM - Any water system in which flow occurs under the natural pressure due to gravity.

GREASE TRAP - An interceptor, or trap, placed in the drain or waste pipe, to prevent waste grease from passing into the sewer system where it will eventually cause trouble in the plumbing.

GROUND WATER - A term applied to water naturally contained in, or passing through, the ground or subsoil.

HYDRAULIC JOINT -- A type of joint used in large water mains where sheet lead is forced tightly into the bell of a pipe by the hydraulic pressure of a liquid.

INCREASER - In pipe work of any kind, a coupling with one end larger than the other. In plumbing, the increaser is generally used at the top of the vent stack as a means of preventing vapor from freezing and clogging the stack in severe climates.

INTERNAL-PARTITION TRAPS - A type of trap which forms its seal by means of an internal partition.

INVERT - The lowest portion of the inside surface of the cross section of any drain pipe or sewer conduit which is not vertical.

LAVATORY - A basin for washing the hands and face; a place in a hotel or school building for washing the face and hands; any room equipped with running water, drainpipe, and fixed bowls, or basins, for washing the face and hands.

LEADER - A pipe or downspout which carries rain water from the gutter to the ground or to a sewer connection; in a heating system, a pipe which conducts warm air from the furnace to the various rooms which are to be heated.

LEAD JOINT - A term usually applied to the forming of a joint between successive lengths of large water pipes. This is done by pouring molten lead into the annular space between a bell and spigot and then making the joint tight by calking.

LEAD WOOL - A specially prepared lead fiber consisting of fine threads which is used in place of molten lead in making pipe joints.

LINE PIPE - A test pipe having recessed and taper-thread couplings, usually with greater length of thread than Briggs' standard.

LIP UNION - A particular type of union which has a lip for preventing the gasket from being squeezed into the pipe so as to obstruct the flow.

LOOP OR CIRCUIT VENT - The extension of a horizontal soil pipe beyond the connection at which liquid wastes from a fixture enter the pipe. The extension usually is vertical directly beyond its connection to the soil or waste pipe. The base of the vertical portion of the vent may be connected to the horizontal portion of the soil or waste stack between the fixtures which are connected to the pipe.

MALLEABLE-IRON PIPE HANGER - A pipe hanger consisting of a lag screw, a piece of pipe, a socket, and an adjustable ring.

MECHANICALLY SEALED TRAP - A type of sealed trap, provided with a hollow metal ball which drops into the seat after each flush of the fixture.

METER STOP - A device placed on a water service-pipe to serve as a controlling stop for the building installation.

NIPPLE - A short length of pipe threaded externally at both ends, for fitting into and connecting two lengths of internally threaded pipes.

OFFSET PIPE - In pipe work of any kind, a section of pipe which leads around some obstacle.

ON CENTER - A term used in taking measurements, meaning the distance from the center of one structural member to the center of a corresponding member, as in the spacing of studding, girders, joists, or other structural members.

OVERFLOW PIPE - A pipe provided to carry off excess water from a tank; also, an emergency outlet for a tank.

PILLAR FAUCET - A faucet or valve joined vertically to a source or supply of water. Also called pillar tap.

PIPE COUPLING - A short collar consisting of a threaded sleeve used to connect two pipes.

PIPE CUTTER - A tool used for cutting steel or wrought-iron pipes. The curved end of the tool partly encircles the pipe and carries one or more cutting disks. As the tool is rotated around the pipe, a screw regulates the feed of the cutter.

PIPE DIE - A screw plate used for cutting threads on pipe.

PIPE FITTINGS - A term used in reference to ells, tees, and various branch connectors used in connecting pipes.

PIPE HANGERS - A term applied to various types of supports, such as clamps and brackets, for cast-iron or galvanized steel soil pipes.

PIPE THREAD - A V-shaped thread cut on a taper of 3/4 of an inch per foot, which insures a perfectly tight joint; used on pipes and tubing.

PIPE VISE- There are two kinds of pipe vises used in the plumbing trade--the hinged-side type with V jaws for small pipes and the chain type used for large pipes.

PLUG - A threaded fitting used to close the end of a valve, union or coupling.

PLUMB - "True" according to a plumb line; perpendicular; vertical; to true up vertically as a wall by use of a plumb line.

PLUMB BOB - A weight attached to a line for testing perpendicular surfaces for trueness; also, to test or adjust with a plumb line.

PLUMB LINE - A strong, heavy string or cord with a weight on one end. It is used to establish a perpendicular line.

POURING ROPE - An asbestos rope used during the process of making a horizontal calk joint. After the joint has been filled with oakum, the pouring rope is placed in position and held with a clamp. A small quantity of clay is then applied to the rope which is built into a well into which the hot lead is poured to complete the calking of the joint.

REDUCER - Any one of the various pipe connections, such as a reducing sleeve, reducing ell, or reducing tee; so constructed as to permit of the joining of pipes of different sizes.

RISER PIPE - A vertical pipe which rises from one floor level to another floor level, for the purpose of conducting steam, water, or gas from one floor to another.

ROOF TERMINAL - The upper end of a soil pipe, usually consisting of a cast-iron pipe which extends about 18 inches above the surface of a roof. In cold climates, roof terminals are designed to resist closure by frost.

ROUGHING-IN - In building, a term applied to doing the first or rough work on any part of the construction, as roughing-in plastering, plumbing, and stairs.

RUN - That part of a pipe or fitting which continues in the same straight line as the direction of flow in the pipe to which it is connected.

RUST JOINT - A watertight joint between adjoining lengths of guttering or pipes, in which some oxidizing agent is employed either to cure a leak or to withstand high pressure. Such a joint is formed by packing the socket with a mixture of iron filings, crushed sal ammoniac, and sulphur.

SEAL - The presence of water in the lower section of the U of a trap, the purpose of which is to prevent noxious gasses and/or odors from finding their way from the sewage system into the residence or other structure being served.

SERVICE ELL - An elbow having an outside thread on one end.

SERVICE PIPE - A pipe which connects a structure with a water or gas main.

SERVICE TEE - A tee having inside threads on one end and on the branch, but having outside threads on the other end of the run.

SEWAGE - Any waste material carried away by a sewer. Also called *sewerage*.

SEWER - A pipe or closed channel for carrying away sewage, storm water, or waste water from industrial plants for sanitary purposes.

SEWER GAS - A self-generated combustible gas which collects in sewer pipes and tanks. It has a slow rate of flame propagation.

SEWER PIPE - A conduit or pipe for carrying off water or sewage. Such pipes usually are made of cast iron or clay tile.

SEWER TRAP - A device in a sewer system which prevents sewer gas from entering a branch pipe leading to a building.

SILL COCK - A water faucet which is placed at about sill height on the outside of a building. Sometimes called hose cock or hose bib.

SINK BIB - A device such as a stopcock used for starting and stopping the flow of water into a kitchen sink; a bib nozzle.

SIPHON TRAP - A trap fitted to water closets and sinks having a double bend like an S on its side, the lower bend containing the water seal which prevents the reflux of foul odors and gases.

SLOP SINK - A type of sink used for the disposal of scrub water and for other purposes. It is constructed with a trap standard to the floor or to the wall. The basin receptacle is deep enough to allow a pail to be placed under the water supply device.

SOIL PIPE - A vertical drain pipe conveying waste matter from a water closet to the drainage system of a building.

SOIL STACK - The main vertical pipe which receives waste material from all fixtures.

SPIGOT - The plain end of a pipe which enters the enlarged end of the next pipe to form a joint between the two lengths; the plug or peg used to close the vent in a pipe. A term sometimes applied to a faucet or cock.

SPIGOT-AND-SOCKET JOINT - Each length of cast-iron pipe is made with a plain or spigot end of one length fitting into the enlarged or socket end of the next length.

STACK PARTITION - A partition wall which carries the stack or soil pipe; sometimes constructed with 2 x 6 or 2 x 8 studs, and continuous from first floor to attic lines.

STANDPIPE - A tall vertical pipe for holding a liquid such as water; used to secure a uniform pressure in a city water--supply system.

STILLSON WRENCH - The pipe wrench which is commonly used by plumbers; named for its inventor.

STOPCOCK - A type of valve consisting of a body with a tapered opening into which a plug of corresponding taper is fitted. The flow can be turned on or off by turning the plug through an arc of 90 degrees.

STRAIGHT TEE - A tee which has all openings of the same size.

STRAP PIPE HANGER - A pipe hanger consisting of a metal strap or band nailed or screwed to the ceiling or a rafter, and slung around a suspended pipe.

SUMP - A pit or depression in a building where water is allowed to accumulate; for example, in a basement floor to collect seepage or a depression in the roof of a building for receiving rain water and delivering it to the downspout. A device used for removing water from such a depression is known as s sump pump.

SWEAT JOINT - A type of joint made by the union of two pieces of copper pipe which are coated with solder containing tin. The pipes are pressed together and heat applied until the solder melts.

TEE - In pipe work of any kind, a fitting used in connecting pipe lengths, one of which is to be fixed as a branch of the other; also, a fitting for connecting pipes of unequal sizes, or for changing the direction of a pipe run.

UNION - A connection or coupling for pipes.

UNION JOINT - A pipe fitting in which two pipes are joined so they can be disconnected without disturbing the pipes themselves.

VENT FLUE - A vertical pipe providing an escape for foul gases from a sanitary fixture and leading into the vent stack.

VENT PIPE - A flue or pipe connecting any interior space in a building with the outer air for purposes of ventilation; any small pipe extending from any of the various plumbing fixtures in a structure to the vent stack.

VITRIFIED TILE - In building construction, pipes made of clay baked hard and then glazed so they are impervious to water; used especially for underground drainage.

WARNING PIPE - A pipe fitted to receptacles, such as cisterns, to give warning of - defective valve which may cause an overflow of water.

WASHER - A small metal piece of disk, usually flat, used under a nut to distribute pressure, or between jointing members to insure a tight fitting joint.

WASTE - Material carried away as sewerage.

WASTE PIPE - A pipe for carrying off waste or superfluous fluid, the outlet pipe at the bottom of a lavatory, bathtub, or sink.

WASTE TRAP - A device designed for use in connection with waste pipes leading from sinks and lavatories, to prevent the escape of sewage gas from the waste pipe.

WATER CLOSET - A room equipped with toilet fixtures and facilities.

WATER-PIPE FITTINGS - Cast-iron pipes used for conveying water or gas are connected by various types of fittings, consisting of tees, elbows, curves, and other special types.

WATER SEAL - The water contained in a trap to prevent the flow of air, foul odors, or gas from one side of the trap to the other side.

WIPED JOINT - A joint formed between two pieces of lead pipe. Molten lead is poured upon the joint until the two pieces of pipe are of the right temperature. The joint is then wiped up by hand with a moleskin or clothe pad while the solder is in a plastic condition.

WYE - A fitting or branch pipe, either of cast or wrought iron, which has one side outlet at any angle except a right angle; usually a 45-degree angle unless otherwise specified.

YOKE - A Y shaped fitting for a soil-pipe connection.

CHAPTER III

A. Understanding Plumbing

Plumbing is basically obtaining, controlling, and disposing of water. If we keep these three phases constantly in mind, understanding will be much easier.

I Supply

Today water is supplied in two ways; by the city or community and by private wells.

City water is piped from the water treatment plant, underground down city streets in large pipes called water "mains". Smaller pipes are tapped off the main and brought to the property line or easement, and a meter is installed. From the meter a pipe is brought to the building. The size of these pipes depend upon the estimated consumption. From this point all the pipes that bring water to various fixtures are called "supply" lines.

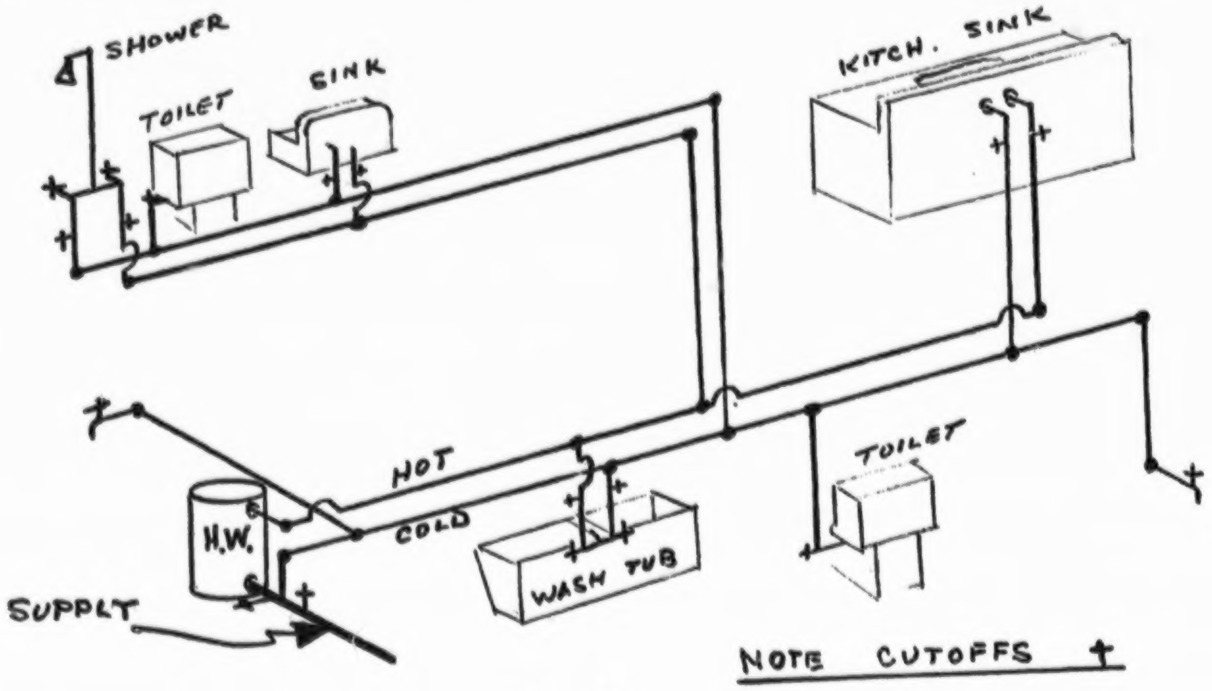


FIG.·300

II Control of Water

Between the water meter and the building should be a MAIN cut-off valve. The main cut-off is usually a gate valve. A gate valve should be used when water is to be turned full on or full off. To use a gate valve as a regulator, for a trickle of water or (3/4 on), may result in damage to the gate and improper sealing. See figure 301.

A globe valve is used to control the amount of water through the line. It may be from a trickle to full open or any amount in between. Globe valves are installed on water appliances such as water heaters, sinks, toilet tanks etc. Globe valves or a form of globe valve may be had in a variety of configurations. See figure 302.

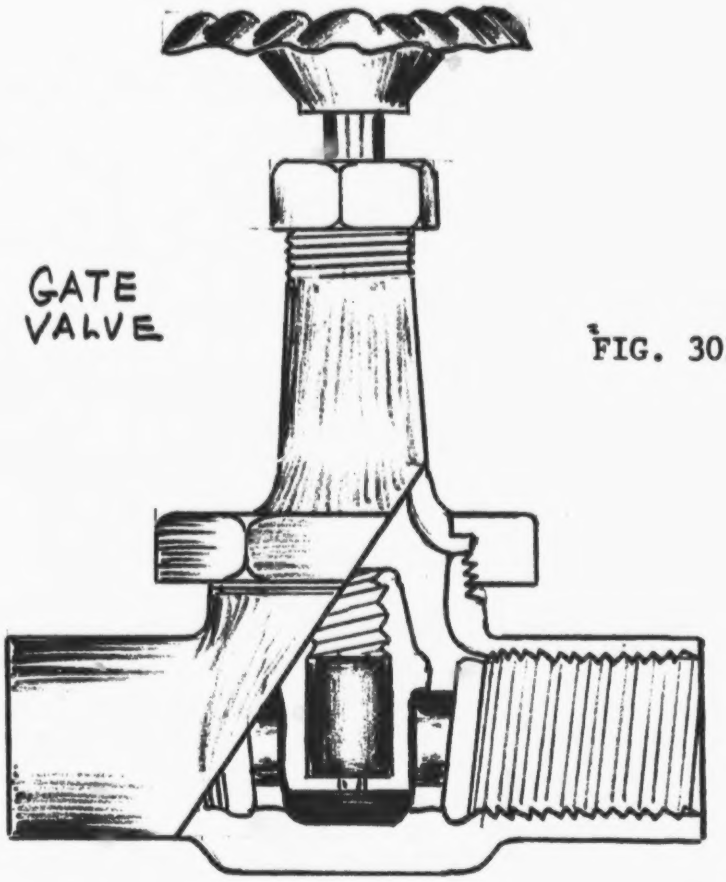
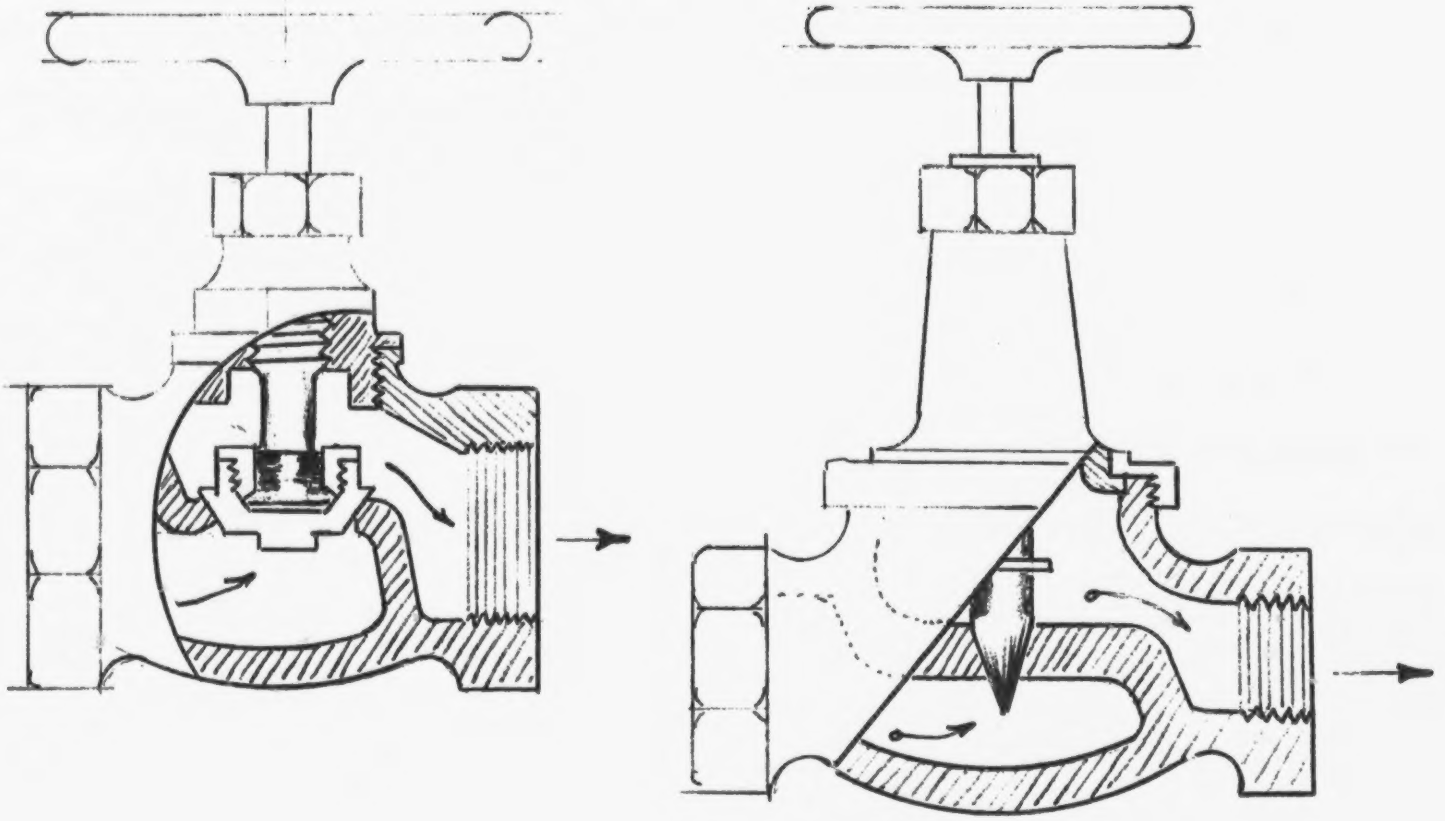


FIG. 301

A check valve is one that allows the water to flow in one direction only. Check valves are used in the supply lines of private wells. The purpose here is to prevent the water from returning down the pipe back to the well, thus losing the prime. Heating systems may also employ a check valve to prevent water from running in reverse in the system.



GLOBE VALVES
FIG, 302

In addition to the common valves discussed there are countless other control devices, such as:

1. Float valves - A device that floats on the level of the water and as the water rises the float causes a mechanical arm to close off the supply. An example of this would be the mechanism in the tank of a water closet, or (in reverse) the low water cut-off on a boiler.

2. Solenoid valves - A solenoid valve is actually a time clock that allows a flow of water for a pre-set amount of time.

3. Water diffusers and strainers - When it is desirable to have a spray of water rather than a steady uncontrolled stream, you may employ a sprinkler, a shower head, a mixer (for hot and cold water) etc. A screen may also be employed to aireate or foam the

water, such as the attachment on the end of a kitchen faucet.

III Disposal of Water

After water has been utilized, some method of disposal must be incorporated. There are (2) basic methods of disposal; to a city sewer or to a septic tank. We are primarily concerned with the piping from the fixture to the entrance to the sewer or septic. Waste pipes are usually larger in diameter than supply lines. There must be installed between the fixture and the drain or waste pipe, a "U" shaped trap. See figure 303. The purpose of the trap is to prevent sewer gases from having a direct open line back into the room where the fixture is. After draining or flushing a fixture, clean water settles in the low end of the "U" trap and forms a block so that gases and vapors cannot pass through. In most cases there is a cleanout plug installed next to the trap so that any obstructions may be removed without going into a major plumbing problem. The cleanout is usually a threaded section that can be removed with a wrench.

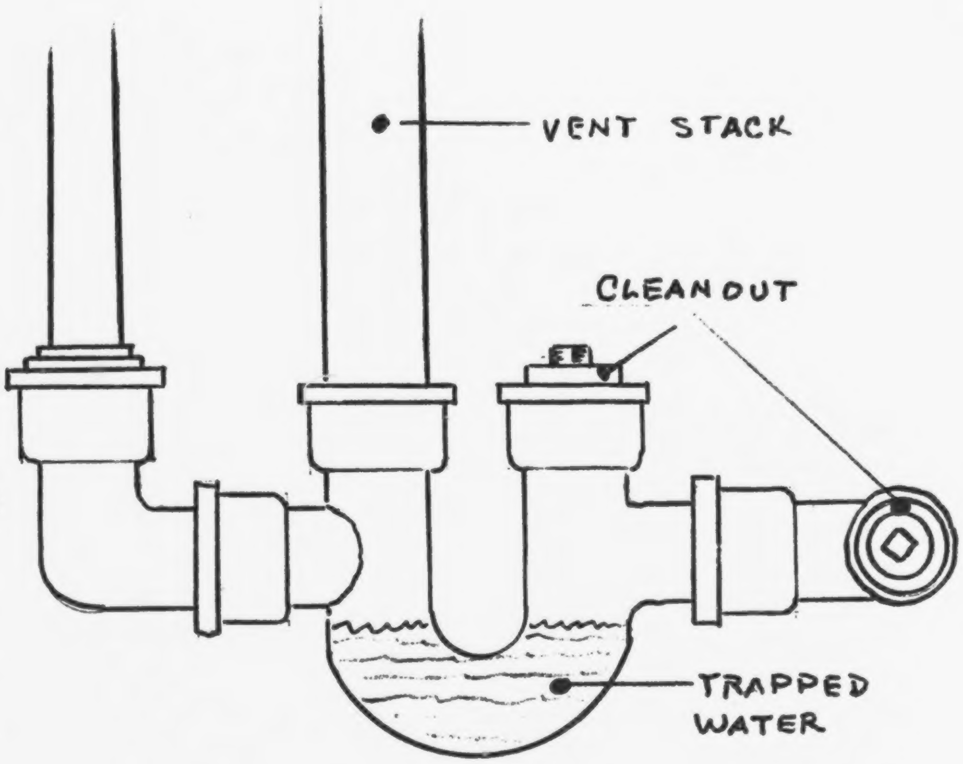


FIG. 303

Soil or waste pipes are cast iron and the various sections are fastened by a caulking method rather than threaded. See figure 304. Any repairs or replacements to those sections should be handled by an experienced plumber.

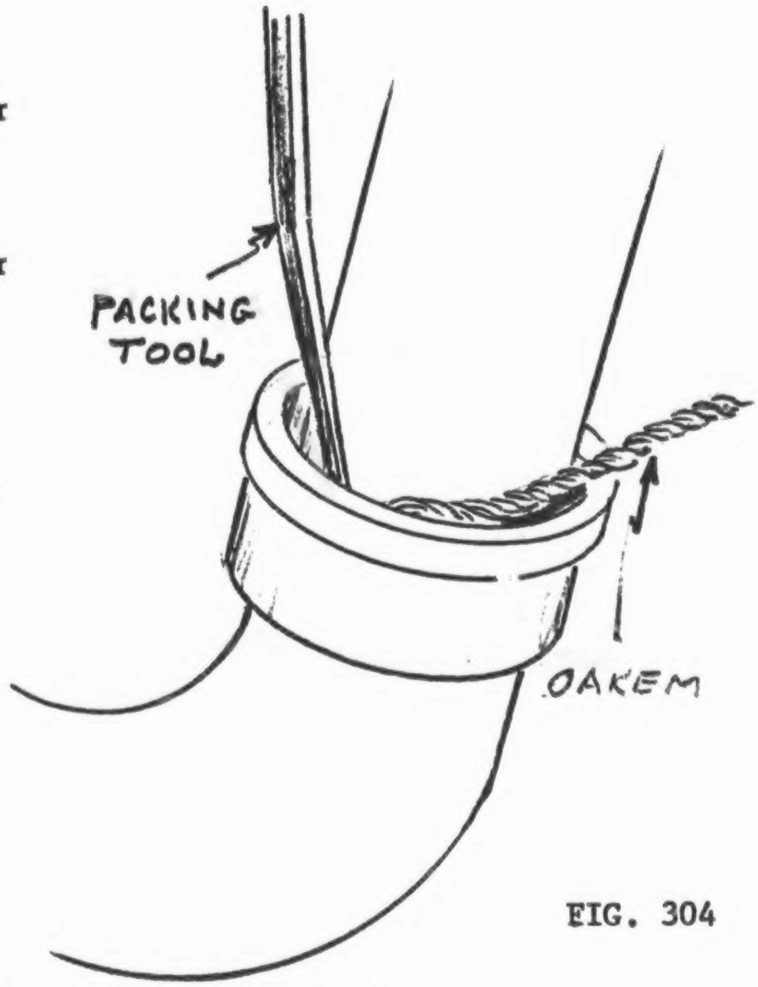


FIG. 304

Copper pipe is usually used to drain from the fixture to the cast iron soil pipe. Copper joints are sweated together rather than caulked or threaded. See figure 305. Again this is an area that should be handled by an experienced plumber. Most of the custodians work involving the drain or disposal system will be in unstopping and cleaning floor drains and toilet drains.

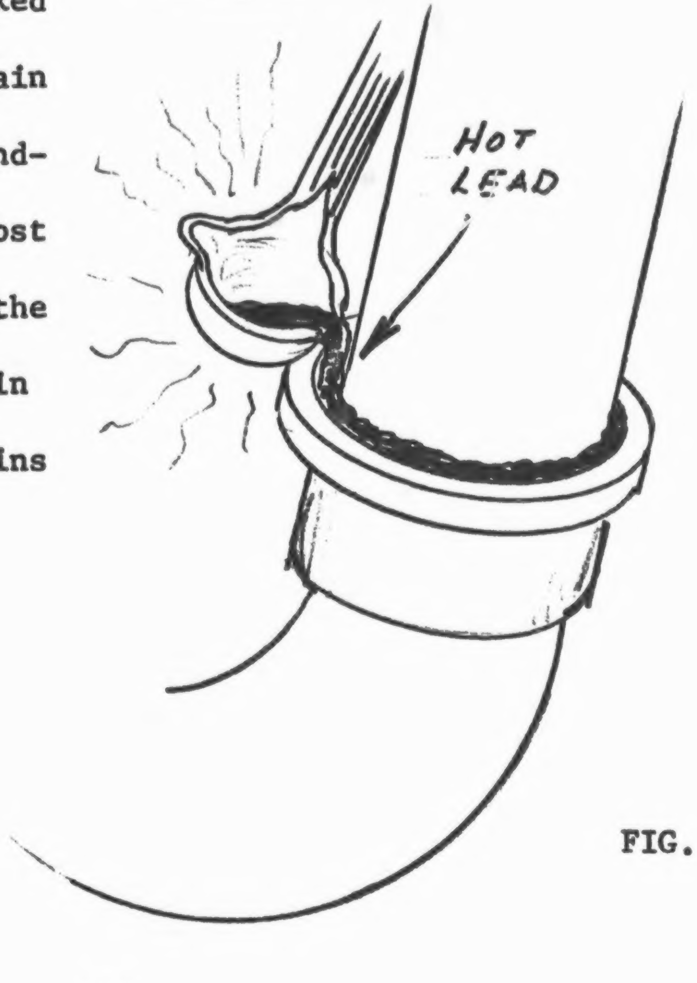


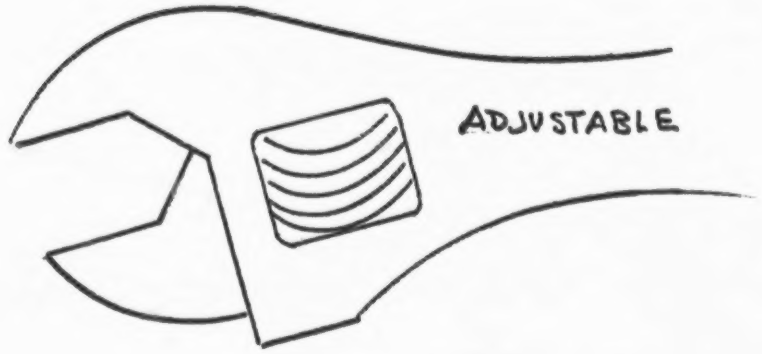
FIG. 305

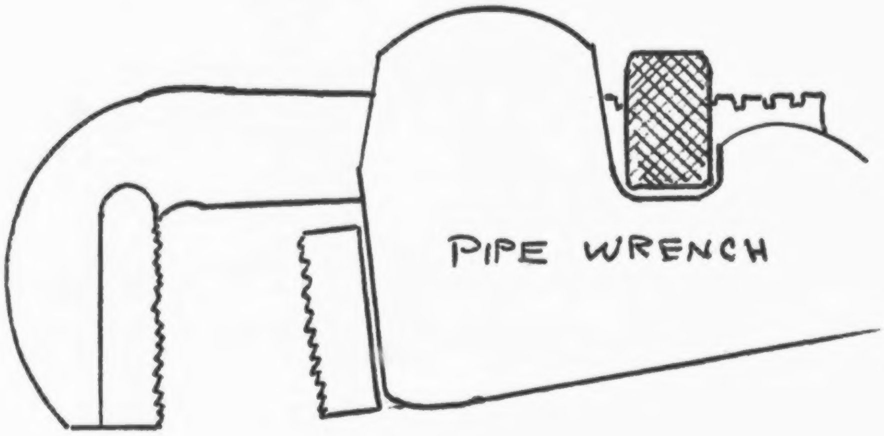
B. Tools & Equipment

1. One adjustable or crescent wrench 2".

2. Two screwdrivers (standard, phillips)

3. Set of allen wrenches.


ADJUSTABLE


PIPE WRENCH

C. Pipes & Pipe Fittings

Supply pipes may be galvanized steel polyethylene, polyvinor-chloride, rigid copper, flexible copper or brass. See figure 306. All come in various size diameters, and all have a variety of fittings. There is also special methods of

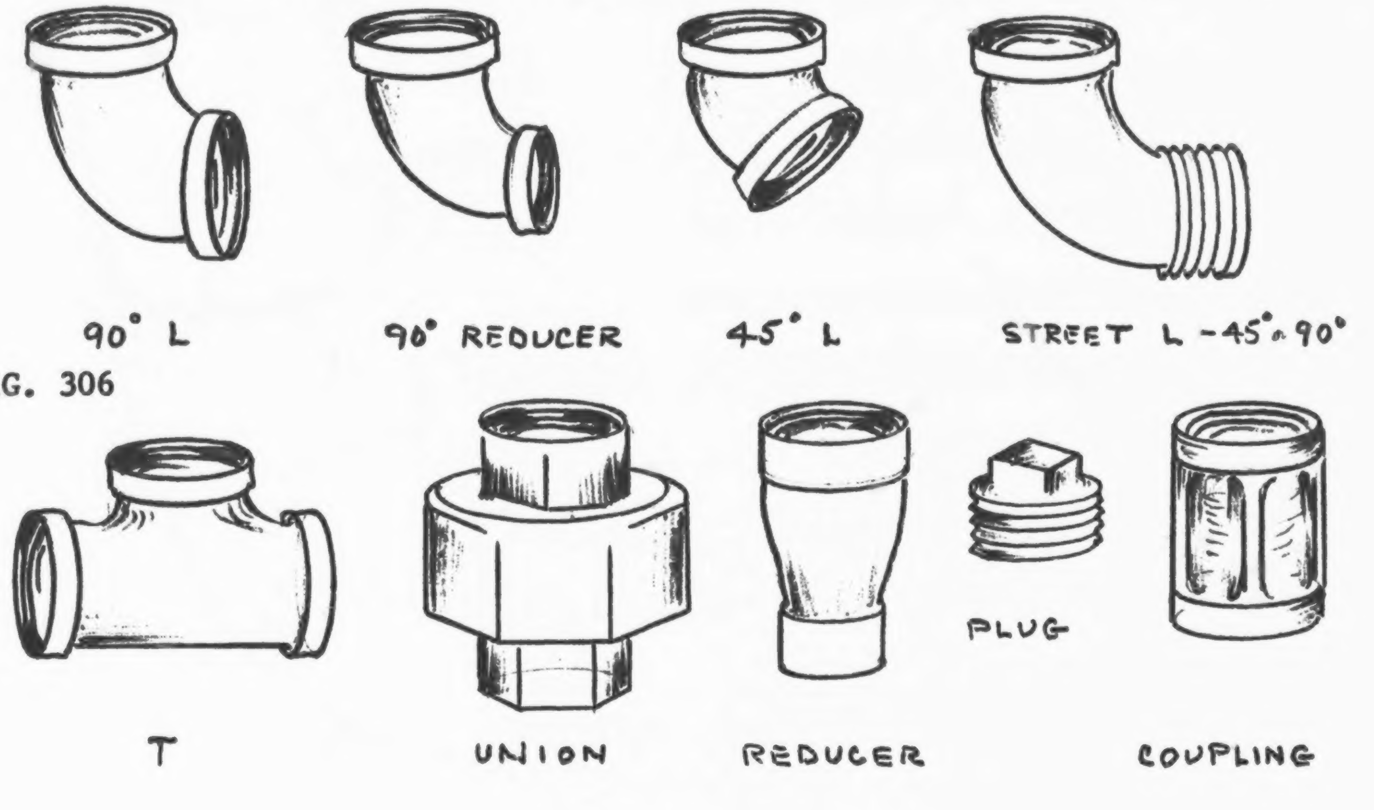

90° L
90° REDUCER
45° L
STREET L -45° & 90°
T
UNION
REDUCER
PLUG
COUPLING

FIG. 306

joining one type to another when the need requires it.

Galvanized pipe and brass pipe is installed by threading. For long straight above ground runs, where accessibility is no problem, galvanized pipe would be advisable. Connection from the fixture faucets to the in-wall galvanized "rough-in" is usually flexible copper tubing, (see figure 307) or threaded brass pipe.

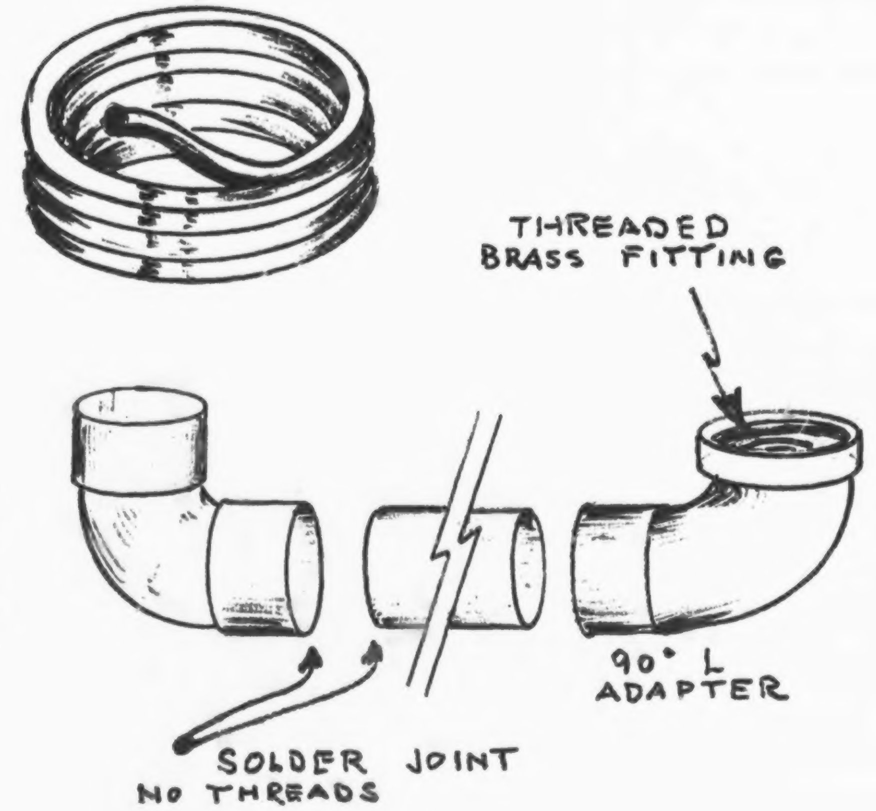


FIG. 307

Plastic pipe may be used for underground supply lines and for sprinkler systems. Plastic pipe tends to expand in freezing conditions thereby preventing cracked joints and split pipe. Joining is done either by a special cement which bonds the two surfaces, or by a clamp arrangement similar to the water hose on your car radiator. See figure 308.

Flexible copper tubing is readily used where many curves and corners are involved. It is used above ground and is approved for in-wall installation. By being able to bend the copper tubing almost all fittings are eliminated. Rigid copper is frequently joined to the flexible copper by using a sleeve and sweating the joint. See figure 309. Rigid copper is used where straight runs are important; it makes a neat, orderly looking job. Since most joints are standardized to certain angles (45°, and 90°), it is important that the straight runs be true i.e., verticals should be plumb. Forcing pipe to fit "T", "Y", and "L" joints etc. is the mark of an amateur. See figure 310.

The plastic type supply lines are used for cold water lines only. Hot water lines must be galvanized, copper, or brass. It should be noted here that when copper is fitted to

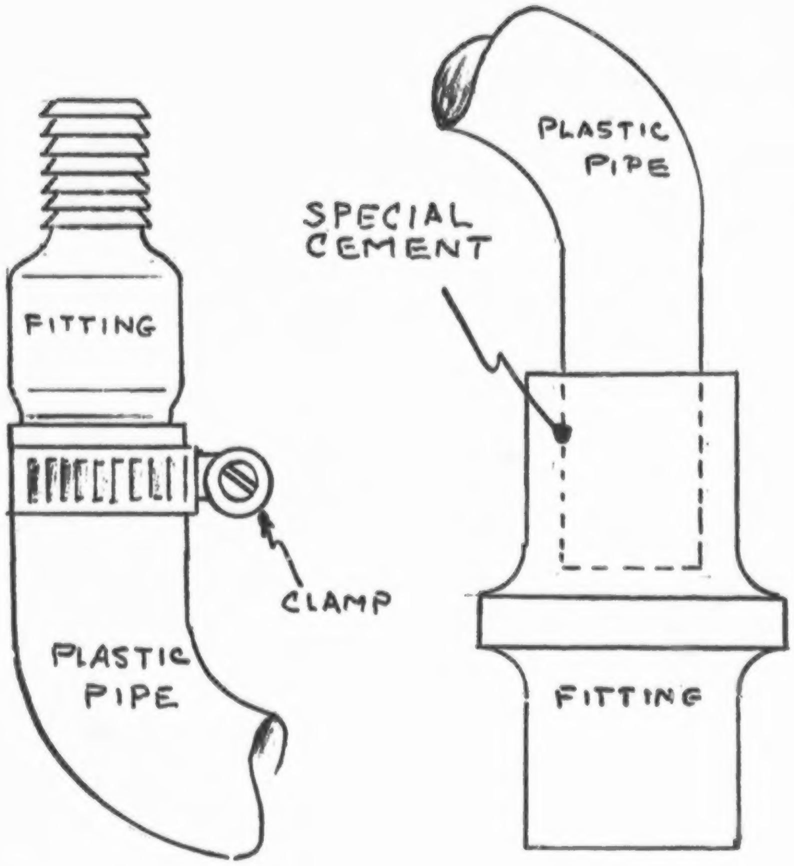

PLASTIC PIPE
SPECIAL CEMENT
FITTING
CLAMP
PLASTIC PIPE
FITTING

FIG. 308

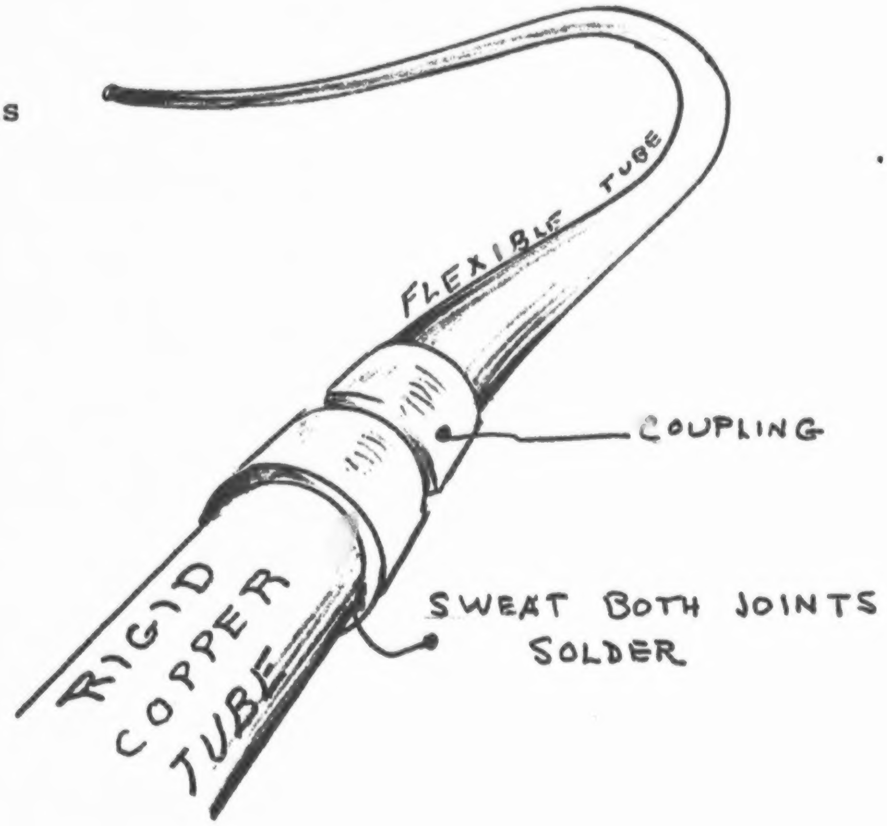

FLEXIBLE TUBE
COUPLING
SWEAT BOTH JOINTS SOLDER
RIGID COPPER TUBE

FIG. 309

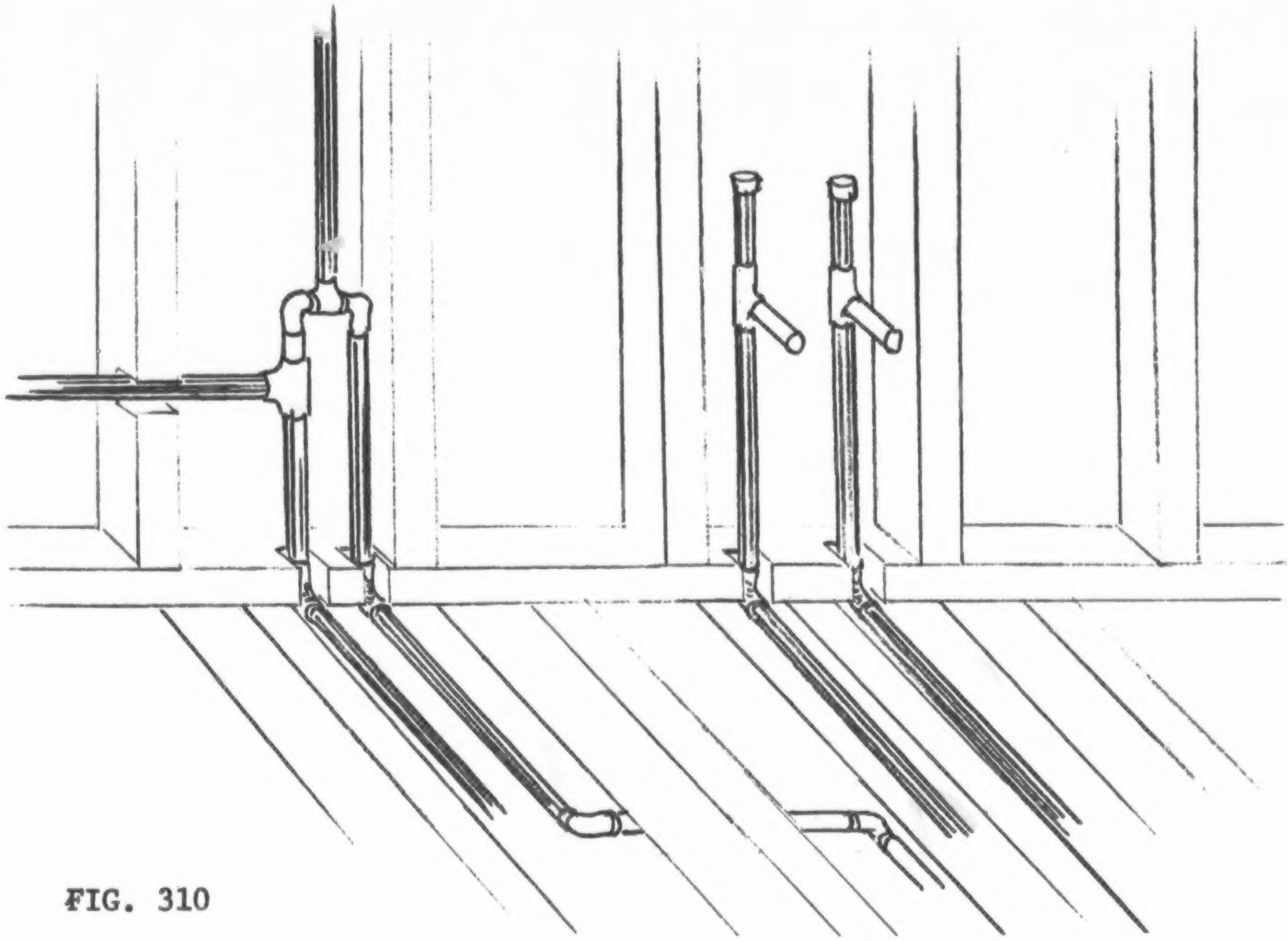


FIG. 310

galvanized pipe in a hot water line, electrolysis or galvanization takes place. Electrolysis is a chemical reaction between the two metals where they meet. This causes corrosion and will mean ultimate replacement. To prevent this action a "buffer" fitting usually vinyl is inserted between the joint so that neither metal touches each other.

The custodian should not tackle any defects in the supply lines up to the faucets on the fixture. Repairs in supply lines should be handled by an experienced plumber. The custodian should however, be thoroughly familiar with the main cut-off valve and all branch cut-off valves, so that if a serious emergency occurs, flooding can be stopped.

Water disposal pipes may be cast iron, rigid copper, ABS-DWV, and cast brass. ABS stands for Acrylonitrile-Butadiene-Styrene and the

DWV stands for Drain, Waste, and Vent. Each of the above pipes may be joined to each other by special adapters. Fittings are all standardized and made in a great variety to meet all situations. See figure 311.

Cast iron pipe has no threads. The joints are filled with oakum which is hammered into the joint. Molten lead is then poured in to tightly seal the joint. This is a special operation requiring considerable skill and should not be done by the custodian. See figure 304.

ABS pipe connections are made by cementing the overlap together. This is also a specialized procedure, and should not be attempted by the custodian.

There are three important features of the drainage system.

1. The proper pitch.
2. Proper traps.
3. Adequate venting.

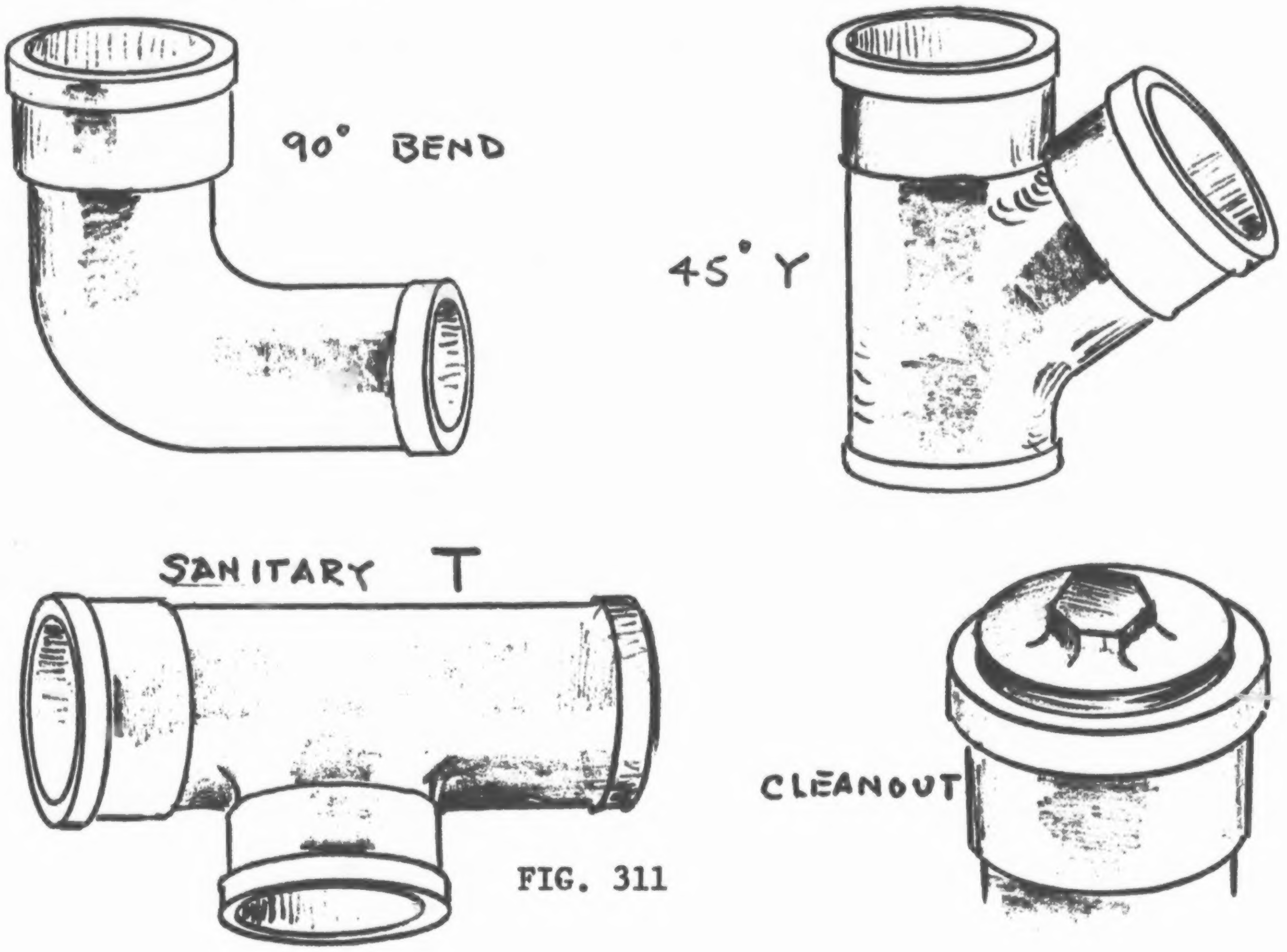


FIG. 311

Pitch - Every pipe in the drainage or waste system must be pitched downward to the sewer connection or the septic tank from each fixture. There should never be sharp angles or obstructions at the joints. Usually the diameter of the pipe increases progressively from the fixture to the sewer. See figure 312.

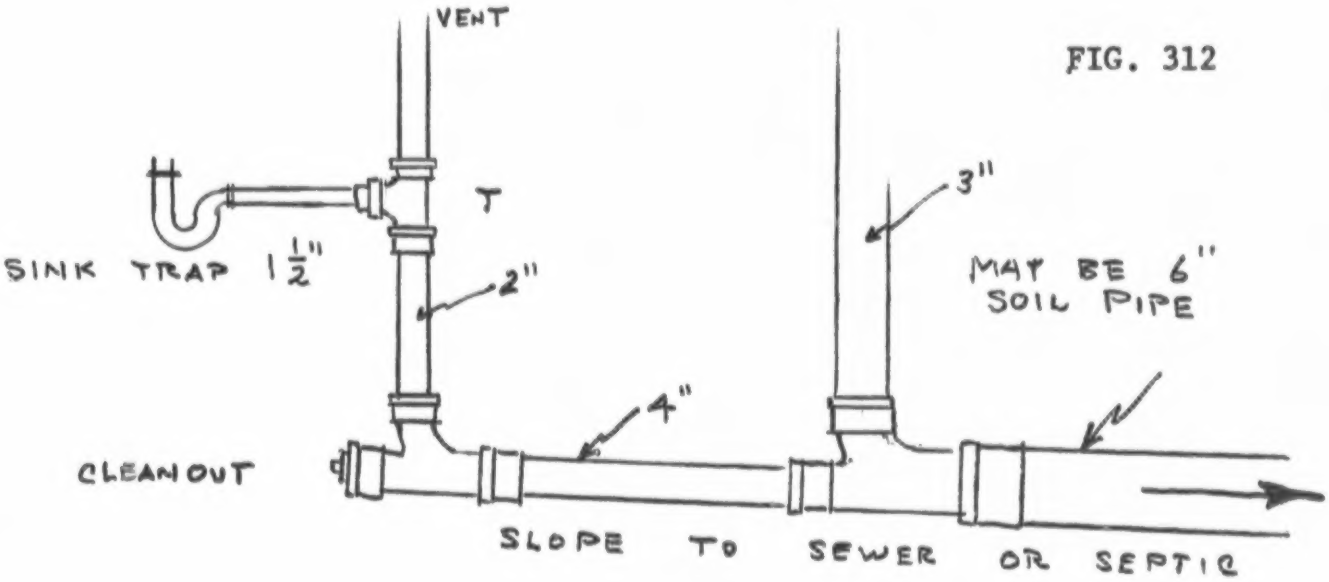


FIG. 312

* APPROX. DIMENSIONS TO SHOW INCREASE.

Traps - Every drain from sinks, showers, toilets etc. must have a gas trap to prevent sewer gas from backing up and out through the fixture drain. This is accomplished by the "U" shaped pipe in which water forms the trap in the "U". See figure 313.

Vents - To prevent pressures between the trap and the sewer connection, a vertical vent is installed. The installation is close to the fixture and in the wall. The vent ascends vertically thru the roof and is usually capped with a rain and rodent guard. As the vent goes through the roof, flashing should be installed to prevent leaks. See figure 314.

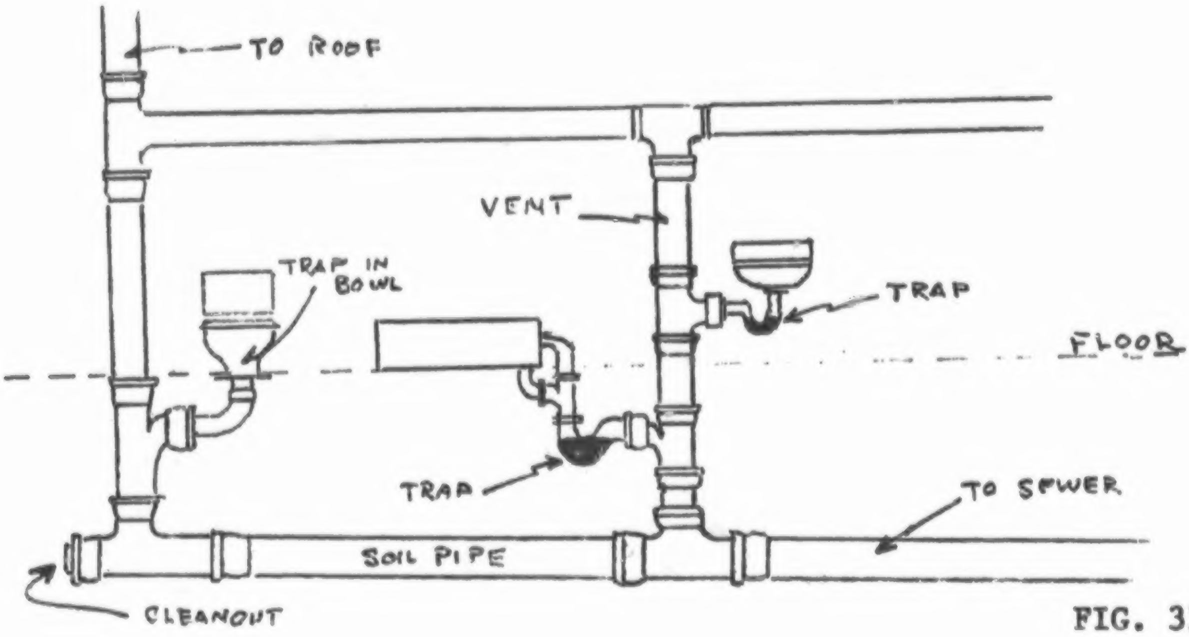
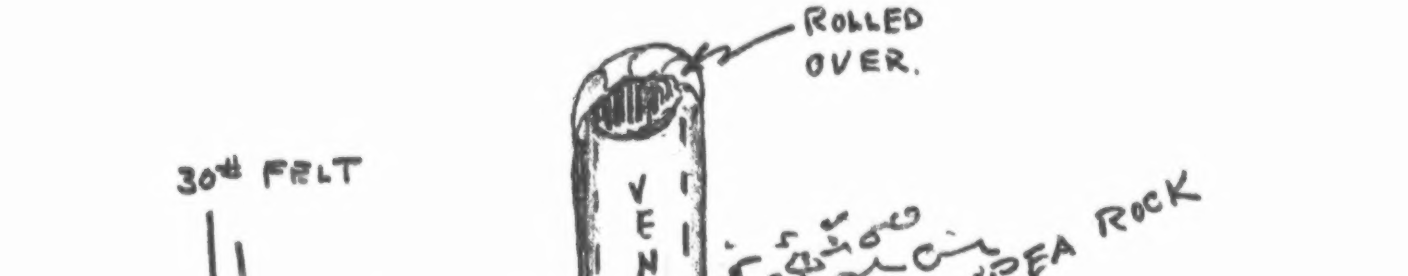

TO ROOF
VENT
TRAP IN BOWL
TRAP
FLOOR
TRAP
TO SEWER
SOIL PIPE
CLEANOUT

FIG. 313


ROLLED OVER.
30# FELT
VENT
PEA ROCK
15#
OVERLAP
METAL
15# FELT
GRAVEL STOP + DRIP STRIP
SHEATHING 1/8
FASCIA 1X8
2X6

•FIG. 314

D. Job Procedure

1. To repair a leaking faucet.

a. Shut water off to fixture.

b. Remove handle (usually a chrome plated screw in the center of the handle.) See figure 315.

c. Unscrew cap nut with a crescent wrench. Care must be taken so as not to scratch or mar the chrome.

d. Unscrew stem or spindle from the faucet. If a second lock type nut is underneath cap nut, this will have to be removed.

e. The washer can now be seen on the end of the stem. It is held by a brass bolt. Unscrew bolt and remove washer. See figure 316.

f. Select new washer (same type) and install--level side toward bolt head.

g. Examine the seat where the

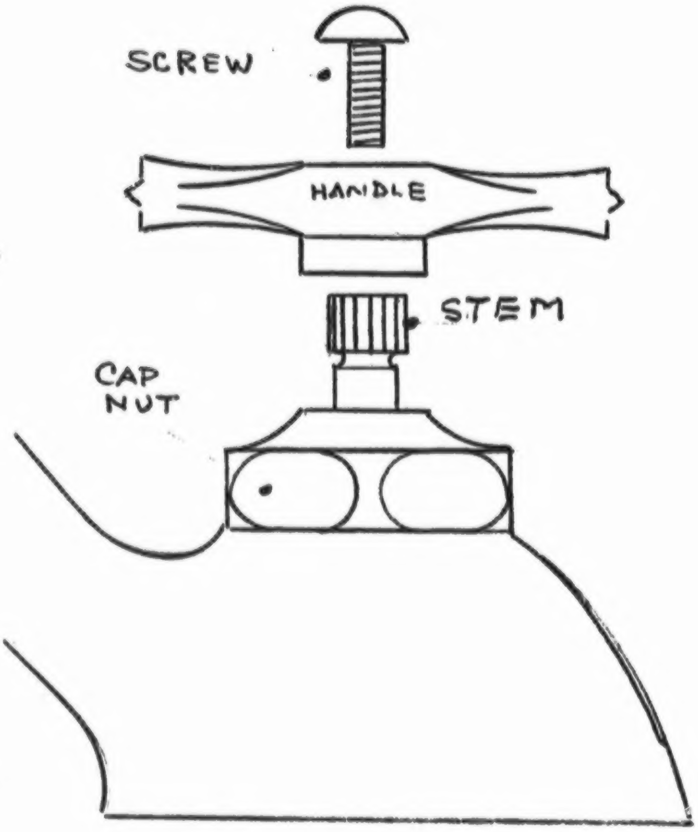


FIG. 315

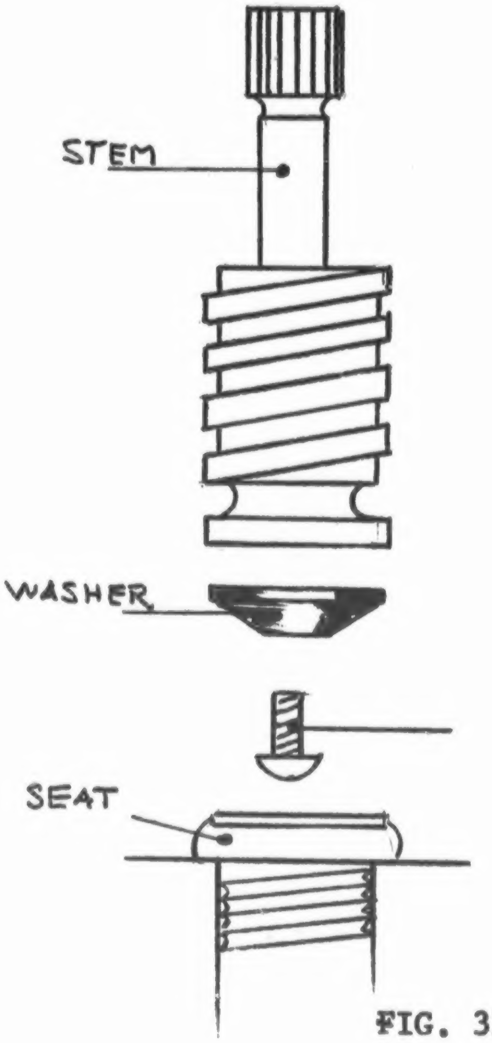


FIG. 316

washer rides. If it is rough or cut, the seat will have to be resurfaced. An inexpensive tool is available for this purpose.

h. Reassemble faucet putting each part back in order.

2. To repair a sloan valve.

a. Shut off water supply.

b. Remove large cap nut. (Careful not to mar the finish.) See figure 317.

c. Remove brass pressure plate.

d. Remove brass valve and rubber diaphragm with valve guide attached.

e. Unscrew valve guide and remove large diaphragm.

f. Clean brass seats and replace with new diaphragm.

g. Reassemble all parts carefully.

h. Check for leaks.

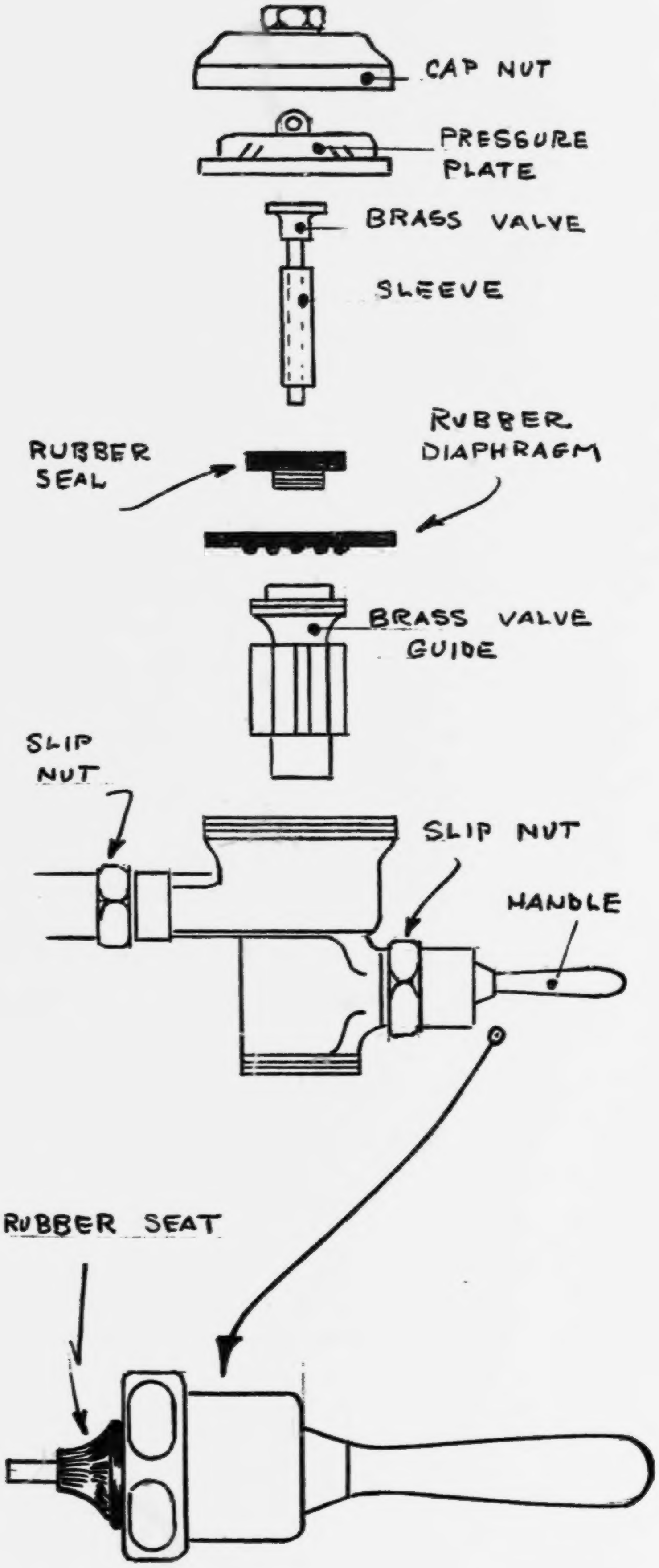

CAP NUT
PRESSURE PLATE
BRASS VALVE
SLEEVE
RUBBER SEAL
RUBBER DIAPHRAGM
BRASS VALVE GUIDE
SLIP NUT
SLIP NUT
HANDLE
RUBBER SEAT

FIG. 317

SLOAN VALVE HANDLE ASSEMBLED

3

If handle leaks;

a. Remove slip nut around handle with wrench--careful of the chrome. See figure 318.

b. Take out handle.

c. Take off washer.

d. Unscrew nylon seat, containing rubber seal.

e. Remove spring and plunger.

f. Replace nylon seat, rubber seal and washer.

g. Reassemble all parts.

h. Check for leaks.

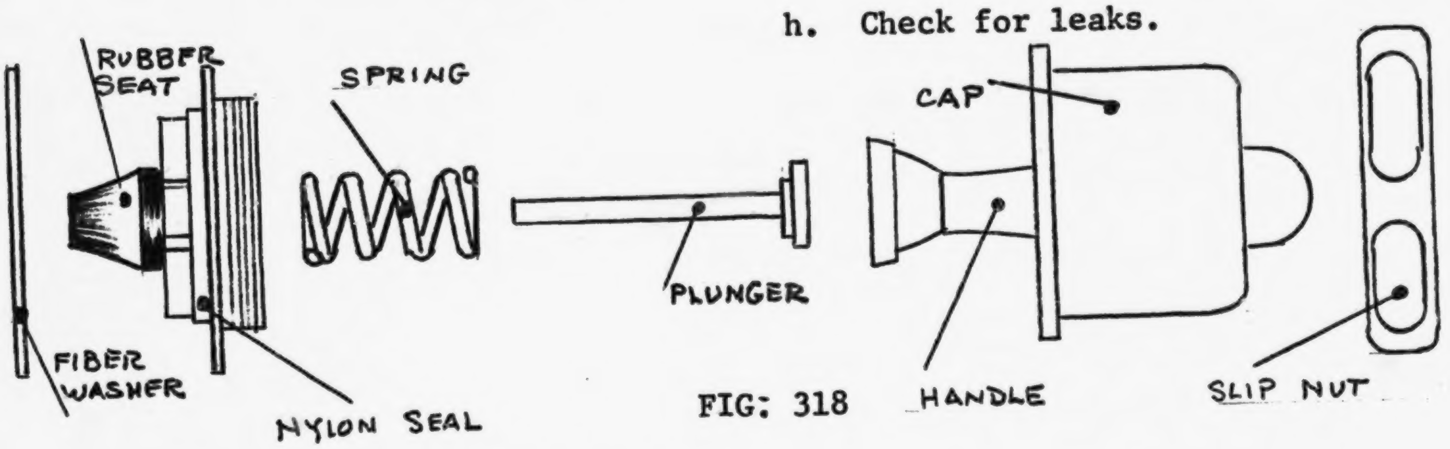

RUBBER SEAT
SPRING
CAP
PLUNGER
FIBER WASHER
NYLON SEAL
HANDLE
SLIP NUT

FIG: 318

3. To repair workings of a water closet tank. [Shut off supply valve] If water does not cut off;

a. Remove tank cover.

b. Raise float manually one inch or so.

c. If water cuts off, the float may be defective or the ball support may have to be bent slightly downward. Bending the arm downward will also limit the amount of water entering tank. See figure 319.

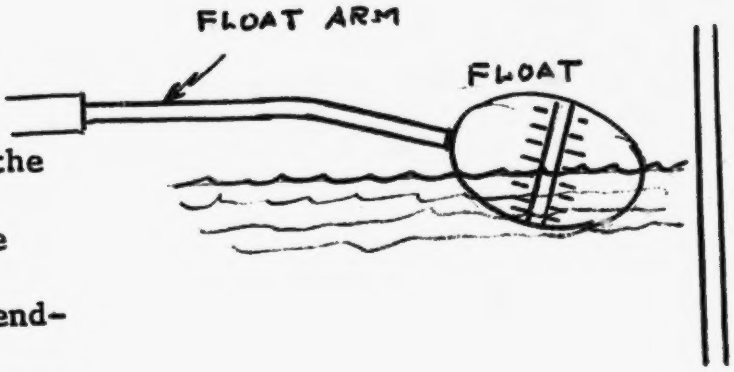

FLOAT ARM
FLOAT

FIG. 319

d. If water still does not cut off after checking float, the valve may be defective.

e. Remove turn screw on horizontal lever and raise lever (You may have to remove float arm support.) See figure 320.

f. As lever is raised the plunger containing a washer will be pulled up. See figure 321.

g. Remove screw holding washer (washer may be only a force fit).

h. Replace with washer of same type.

i. Reassemble all parts in reverse order.

If water continues to run in bowl;

a. Remove tank cover.

b. Inspect ball, ball guide, wire loop, and trip lever.

c. The complete linkage must be all lined up and operating smoothly.

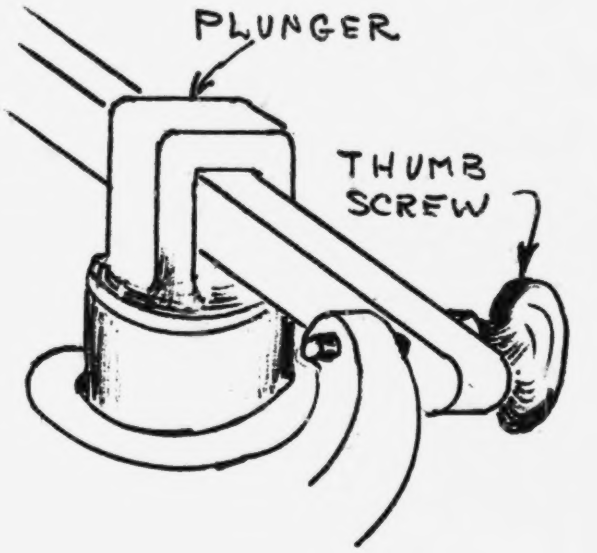


FIG. 320

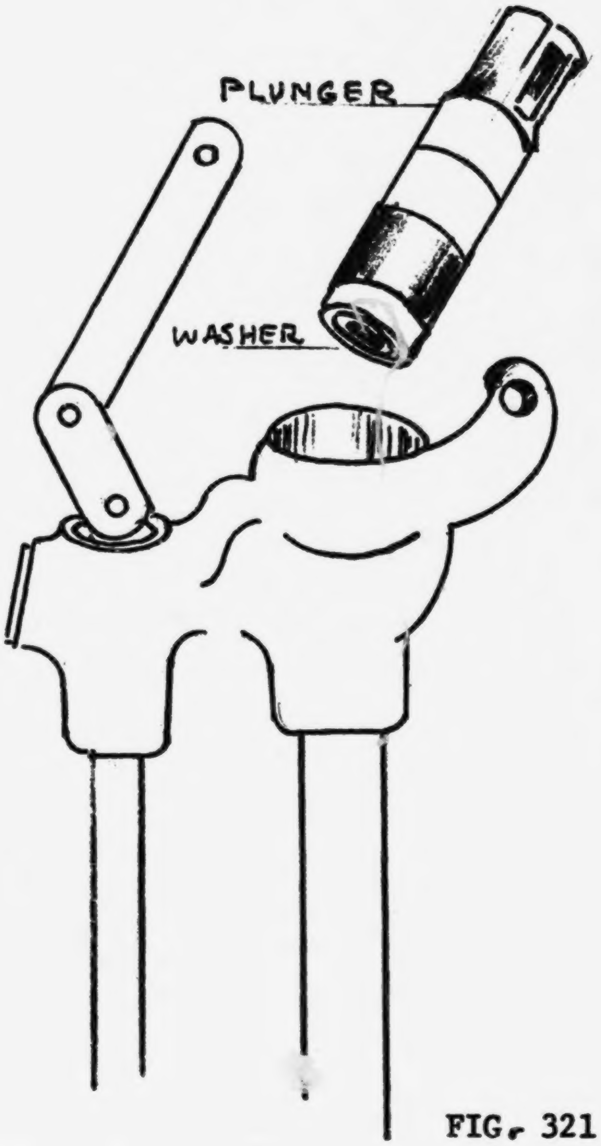


FIG. 321

d. Replace any visible broken wire, make sure guide is over center of ball. See figure 322.

e. Inspect flush valve seat for calcerous deposits or foreign matter restricting proper seating of the ball.

f. Unscrew ball from vertical copper wire.

g. Replace with new ball.

h. Reassemble and check all linkage.

Note: The tank mechanism is subjected to deterioration from corrosion. Inspect all parts while cover is off and replace obviously worn wires, balls or drains.

4. To unstop a clogged toilet;

a. Remove any visible obstructions such as toilet paper etc.

b. Use a rubber plunger (the round ball type). See figure 323.

c. Pour a bucket of water in toilet and observe action.

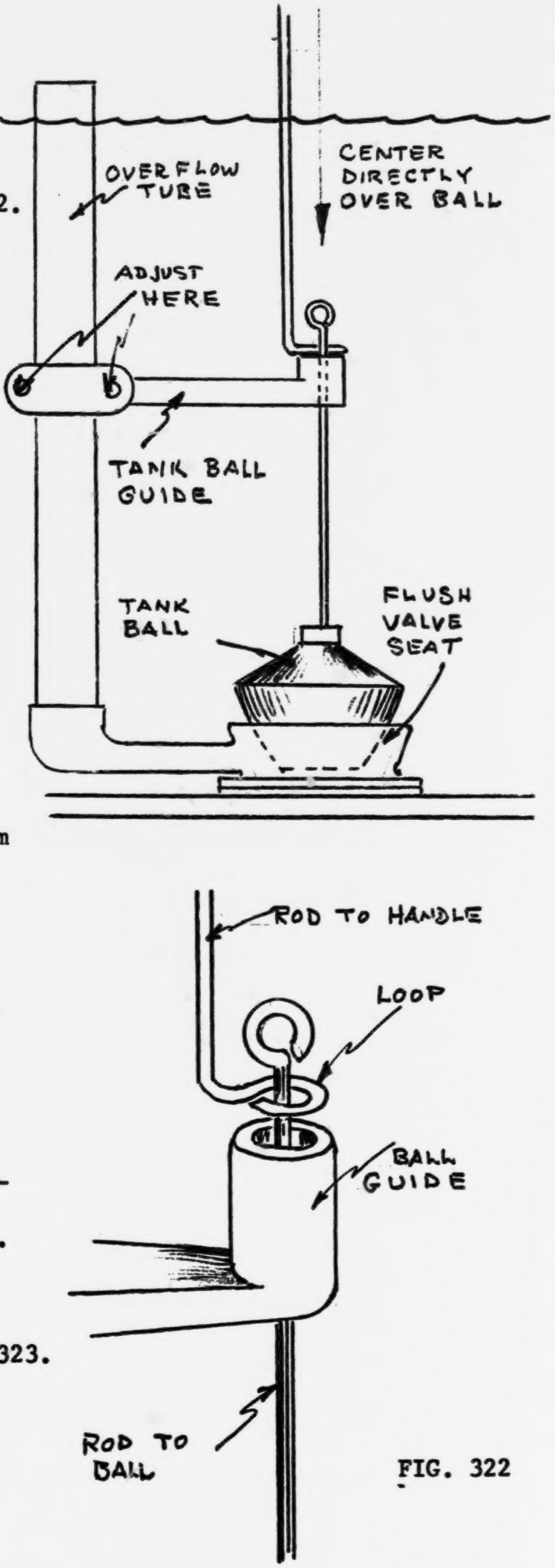

OVERFLOW TUBE
CENTER DIRECTLY OVER BALL
ADJUST HERE
TANK BALL GUIDE
TANK BALL
FLUSH VALVE SEAT
ROD TO HANDLE
LOOP
BALL GUIDE
ROD TO BALL

FIG. 322

d. If water recedes or appears to flush through the trap, the obstruction is removed.

e. If water rises the obstruction still remains. Use a small anger (5') to force through the trap. See figure 324.

f. Pour a bucket of water in bowl. At this point if the water flushes or recedes rapidly, the obstruction is removed.

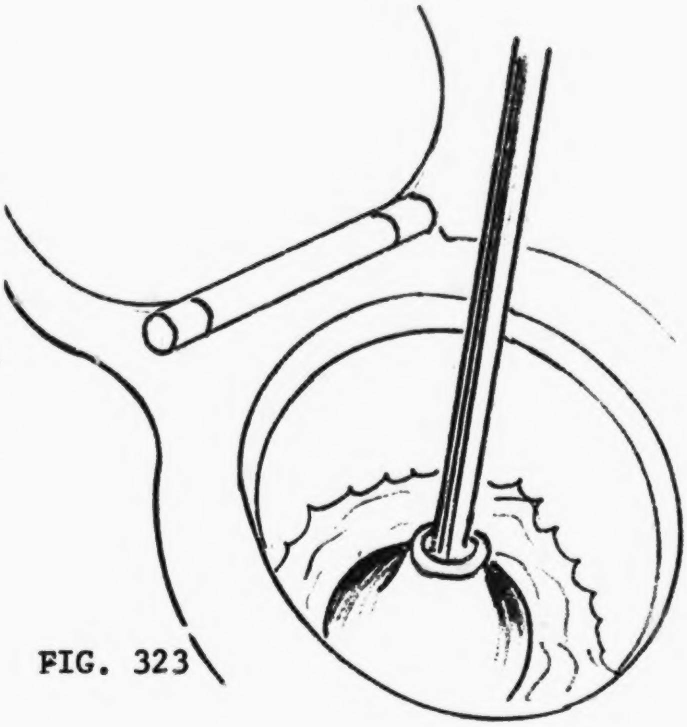
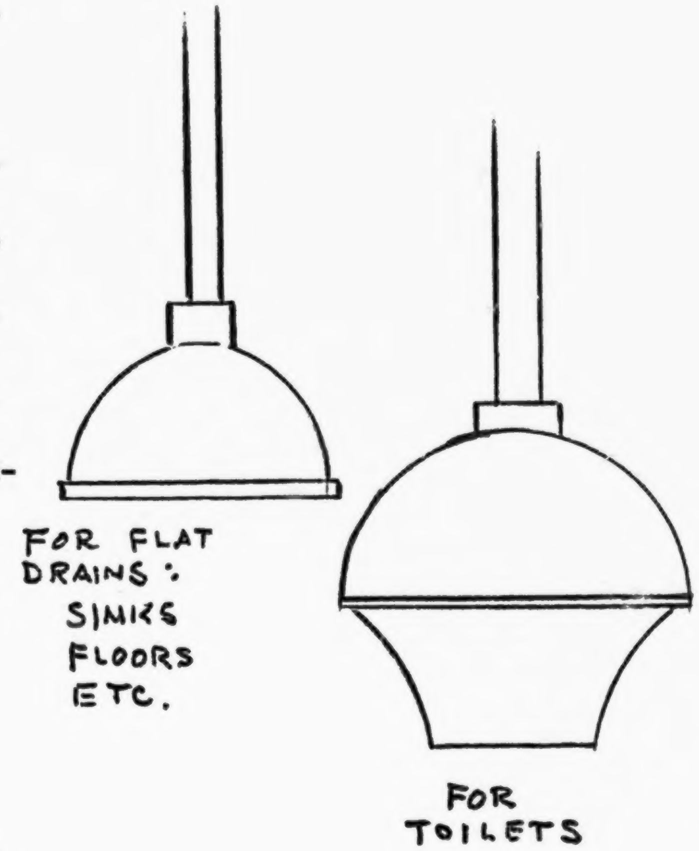


FIG. 323

g. If water remains, the obstruction may be further into the drain system and will require an experienced plumber. Note: Usually if the obstruction is well along the drain lines, more than one fixture will be stopped.



5. To unstop a sink drain.

a. Remove drain stopper (usually a twist to the left). Check for obvious debris such as hair etc. See figure 325.

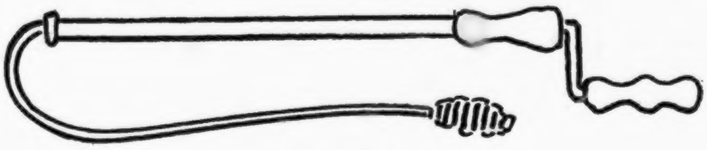


FIG. 324

Some stoppers must be disconnected from rod under bowl. Excessive hair can jam the stopper almost to the point where it will not move. Patient rotating and pulling out small pieces can eventually remove the stoppage.

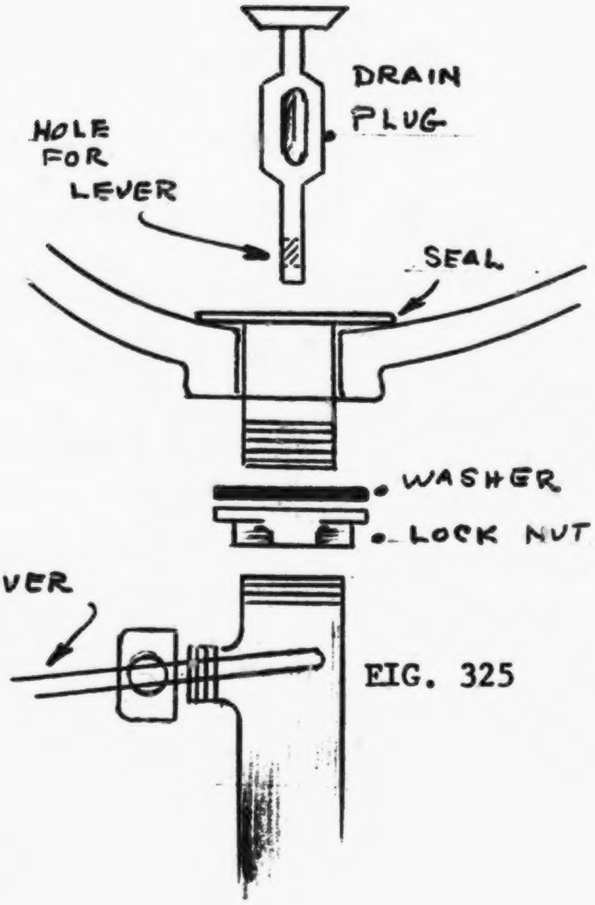

DRAIN PLUG
HOLE FOR LEVER
SEAL
WASHER
LOCK NUT
LEVER

FIG. 325

b. If water still does not flow easily down the drain, the brass-chrome trap may have to be taken loose (if a clean out plug is installed remove plug and clean trap.) See figure 326.

c. To remove trap, use a large crescent wrench or channel lock plier, being carefull not to scratch the chrome. Unscrew both collars holding "U" in place. (Have a large bucket under trap to catch water & sludge.)

d. Clean trap and reassemble. If joints leak, reassemble us-

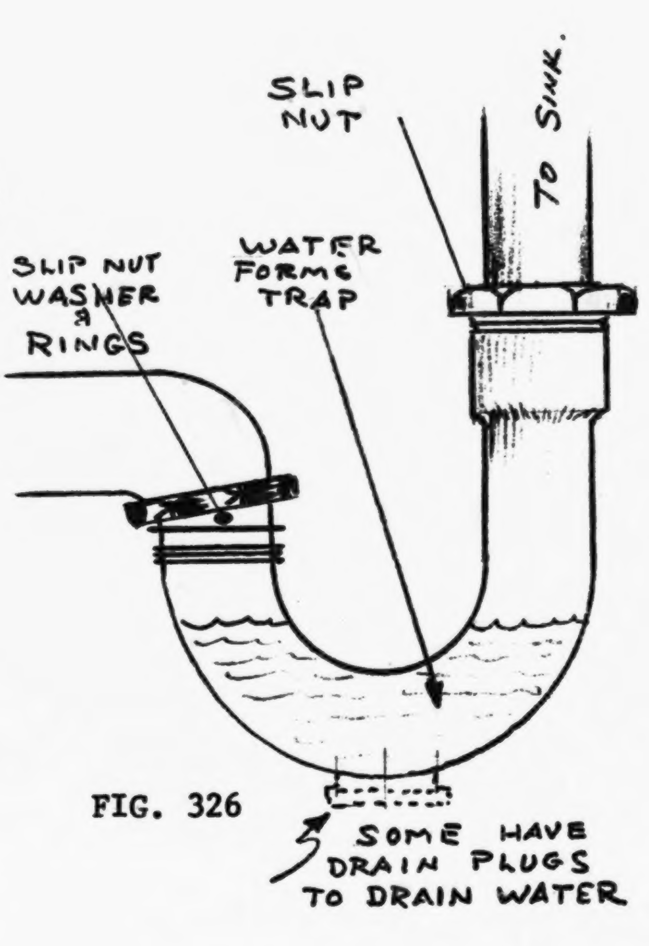

SLIP NUT
TO SINK.
WATER FORMS TRAP
SLIP NUT WASHER & RINGS
SOME HAVE DRAIN PLUGS TO DRAIN WATER

FIG. 326

ing string wound in threads with compound if available.

e. If trap is clear, then the stoppage is further along in the line near the vent stack. This operation requires a snake. See figure 327.

f. When all above procedures fail, leave the job to an experienced plumber.

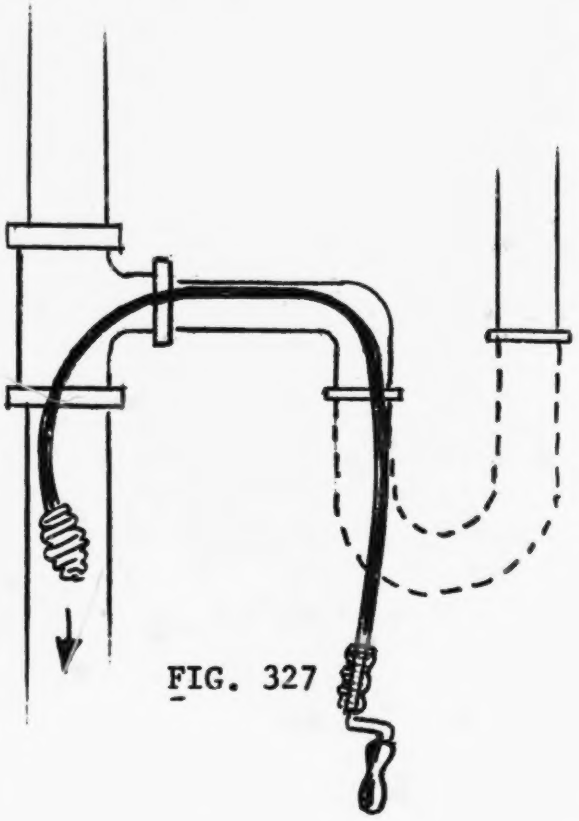


FIG. 327

CHAPTER IV
PAINTING

DEFINITIONS - PAINTING

ABRASIVES - Substances rubbed on wood to smooth it before or between applications of finish coats. Flint, garnet, aluminum oxide, and silicon carbide are common abrasives.

BENZENE (BENZOL) - A material derived from coal tar and widely used as a solvent. Also used for cleaning after finishing.

BENZINE - A liquid obtained from petroleum. Used in dyeing, painting, and as a cleansing agent.

BLEEDING - The movement of stain or dye from the wood into surface coats. For example, a white enamel applied over a mahogany oil stain will bleed (develop pink spots).

BLEND - Mixture, as of two pigments to obtain a desired color.

BLISTERS - Flat, cloudy, or milky-looking spots on finished surfaces.

CASEIN GLUE - An adhesive substance composed of casein (the curd of milk), lime, and sodium salt. It comes as dry powder to which water is added.

DRIER - A solution added to drying oils to quicken the drying.

ENAMEL - A kind of paint in which the vehicle is a drying oil or combination of drying oil and resin. It dries to an even, hard finish. Usually it leaves a gloosy surface, but the addition of a flatting agen can reduce the glossiness.

EVAPORATE - To pass off in vapor or to change a liquid into vapor or gas.

FILLER (WOOD) - A heavily pigmented preparation used for filling and leveling off the pores in open-grained woods.

FLAT PAINT - An interior paint, containing a high proportion of pigment, which dries to a flat or lusterless finish.

FLATTING OIL - A special liquid used with pigment-oil paste to produce a flat paint. It is a clear liquid, consisting primarily of thickened drying oils and turpentine.

GLAZING - Application of a thin transparent color over a previously finished surface to produce a hard finish and provide luster, or to produce a blended effect.

GLOSS - A shiny, lustrous finish which reflects light. The term also refers to paint or enamel that dries to a high sheen or luster, usually with a hard, smooth coat.

HOLIDAYS - Areas of surface missed by a painter.

INFLAMMABLE - Capable of being easily set on fire.

LAC - A natural resin secreted by insects that live on the sap of certain trees in oriental countries. The base for shellac.

LACQUER - A varnish-type solution used for finishing wood, metal, porcelain, and similar materials. Lacquers dry quickly and leave a tough, durable, flexible, light-weight film. They should not be used over oil-base paints because they contain solvents that will cut such paints. There are several types of lacquers. Cellulose lacquers have a base of nitrocellulose or pyroxyline; others have a resin base.

LINSEED OIL - A vegetable oil pressed from the seeds of the flax plant. Used extensively in the manufacture of oil base paints and finishes.

MINERAL SPIRITS - A petroleum solvent; a substitute for turpentine.

NAPHTHA - Any of several volatile, inflammable liquids obtained by distilling certain materials containing carbon. Naphtha is used as a solvent or thinner in varnish making and as a fuel. Petroleum naphtha is also known as benzine.

NATURAL FINISH - A transparent finish, usually a drying oil, sealer or varnish, applied to wood for the purpose of protection against soiling or weathering. Such a finish should not seriously change the original color of the wood or obscure its grain pattern.

OIL PAINT - A paint in which the vehicle is oil.

OIL VARNISH - A varnish consisting of a hard resin combined with a drying oil and drier thinned with a volatile solvent. After application, the solvent dries first by evaporation, then the oil dries by oxidation.

OXIDIZE - To unite with oxygen - a chemical reaction.

PIGMENT - Finely ground powders that are insoluble and provide color and body to a finishing material.

PRESERVATIVE - Any substance that, for a reasonable length of time, is effective in preventing the development and action of wood-rotting fungi, borers of various kinds, and insects that make wood deteriorate.

PRIMER - The first coat of paint in a job that consists of two or more coats; also the paint used for such a coat.

RESIN - A sticky material obtained from the sap of certain trees and plants (natural resins) or produced synthetically by chemical combinations of coal-tar derivatives and other organic substances (synthetic resins). Resins are widely used in making varnishes and paints.

ROSIN - A hard resin used in making certain varnishes.

RUBBER-EMULSION PAINT - Paint, the vehicle of which consists of fine droplets of rubber or synthetic rubber dispersed in water.

RUBBING COMPOUND - An abrasive material used to produce a smoothly finished wood surface.

RUNS - Also called "sags" and "curtains." Irregularities in a surface finish usually caused by too heavy an application.

SAG - An uneveness or irregularity in a coat of paint, varnish, or lacquer. It results if too much of the liquid is allowed to collect in one spot or area.

SANDING - Rubbing sandpaper or similar abrasive over a surface before applying a finish.

SEALER - A finishing material, either clear or pigmented, that is usually applied directly over uncoated wood to prevent subsequent coats of paint of varnish from seeping into the wood.

SEMIGLOSS PAINT OF ENAMEL - A paint of enamel made so that its coating, when dry, has some luster but is not very glossy.

SHELLAC - A preparation made by dissolving lac in alcohol, and used commonly in the finishing of wood. Lac is a resinous substance secreted by a tropical insect.

SIZING - (1) Working material to the desired size. (2) A coating of glue, shellac, or other material applied to a surface to prepare it for painting or other method of finish.

SOLVENT - A liquid in which things can be dissolved. Also, more loosely, a liquid in which tiny particles of a substance can be dispersed in suspension, without actually dissolving. Solvents commonly used in wood finishing are turpentine, alcohol, and petroleum and coal-tar distillates. The solvent in a finishing material usually evaporates, leaving the pigment or other necessary ingredients dry on the finished surface.

SPAR VARNISH - A varnish consisting mainly of drying oil and the harder types of resins. It is waterproof and strongly resistant to the damaging effect of moisture and sunlight.

SPRAY BOOTH - A sheet-metal booth or small room used for spray finishing.

STAIN - A discoloration in wood. It may have such diverse causes as micro-organisms, metal, or chemicals. The term also applies to materials that are used in coloring wood.

STAIN, SHINGLE - A form of paint, very thin in consistency, intended for coloring rough-surfaced wood, such as shingles, without forming a coating of significant thickness or gloss.

TACK RAG - A piece of cheesecloth or cotton rag moistened with thinned varnish. It is used to pick up small particles of dust.

TACKY - Not quite dry; sticky.

THERMOSETTING GLUES AND RESINS - Glues and resins that are cured with heat and do not soften when subsequently subjected to high temperatures.

THINNERS - Volatile liquids that are used to regulate the consistency (thickness) of finishing materials.

TINT - A color produced by adding white pigment or paint to a colored pigment or paint, with the amount of white greater than the amount of colored.

TUNG OIL - A yellow drying oil obtained from the seed pods of tung trees, and widely used in water-resistant varnishes, laquers, and high-gloss paints.

TURPENTINE- A volatile solvent used in wood finishes, which is made by distilling the gum obtained from the pine tree.

UNDERCOAT - A coating applied prior to the final or top coat of a paint job.

VARNISH - A thickened preparation of drying oil, or resin and drying oil. When applied to a surface it leaves a hard glossy, transparent coating. It may also be mixed with pigments to make enamels. Clear varnish is a slightly yellow, semi-transparent liquid.

VEHICLE - The liquid portion of a finishing material; it consists of the binder (nonvolatile) and thinners (volatile).

VOLATILE - Easily vaporized.

WATER PAINT - A paint in which the vehicle is a water emulsion.

WATER REPELLENT - A liquid designed to penetrate into wood to make it resist water.

WATER STAIN - A colored dye that is soluble in water.

WAX - A fatty material obtained from the honeycombs of bees or from similar plant, animal, or mineral substances, and used for providing an attractive, protective coating, as for wood.

CHAPTER IV

A. UNDERSTANDING PAINTS AND FINISHES

The term "surface finishing" is a broad term and includes all types of finishes and surfaces involved. It might be difficult to ascertain exactly how far back people were engaged in applying a finish to a given surface. We can however, assume that any application used by ancient civilizations had a purpose other than providing employment. The reasons for surface finishing today is basically the same as in ancient times, i.e., protection and appearance.

Advances in technology have produced a wide variety of surface finishes. Not many years ago paint was limited to oil or water base (calcimine). Prior to 1920, house paints were composed primarily of linseed oil and white lead. Since 1920 a new material was introduced called titanium-dioxide. This improved the whiteness of the paint, by allowing a self whitening action to take place as the paint wore away. Color fast qualities began to appear such as acrylic resin and alkyd resins. Industrial chemical manufacturers are constantly introducing new additions to make the colors last, wear longer, and make application easier. The same type of advancement applies to enamels, varnishes, epoxies, etc.

In order to aid the student, finishes may be classified as follows:

PAINTS

EXTERIOR

1. White Lead Paint -- consists of carbonated white lead, linseed oil, drier, coloring and thinner. Where moisture is a problem, this is a good paint to use.

OUTDOORS	HOUSE PAINT	TRANSPARENT SEALER	CEMENT BASE PAINT	LATEX BASE PAINT	EXTERIOR CLEAR FINISH	ALUMINUM PAINT	WOOD STAIN	ROOF COATING	ROOF CEMENT	ASPHALT EMULSION	METAL ROOF PAINT	TRIM-AND-TRELLIS PAINT	AWNING PAINT	SPAR VARNISH	PORCH-AND-DECK PAINT	PRIMER OR UNDERCOATER	METAL PRIMER
CLAPBOARD SIDING	⊙					O										O	
BRICK	⊙	O	O	O		O										O	
CEMENT & CINDER BLOCK	⊙	O	O	O		O										O	
ASBESTOS CEMENT	⊙			O												O	
STUCCO	⊙	O	O	O		O										O	
NATURAL WOOD SIDING & TRIM					O		O							O			
METAL SIDING	⊙					⊙						⊙					O
WOOD FRAME WINDOWS	⊙					O						⊙				O	
STEEL WINDOWS	⊙					⊙						⊙					O
ALUMINUM WINDOWS	⊙					O						⊙					O
SHUTTERS & OTHER TRIM	⊙											⊙				O	
CANVAS AWNINGS													O				
WOOD SHINGLE ROOF							O										
METAL ROOF											⊙						O
COAL TAR FELT ROOF								O	O	O							
WOOD PORCH FLOOR															O		
CEMENT PORCH FLOOR				O											O		
COPPER SURFACES														O			
GALVANIZED SURFACES	⊙					⊙						⊙		O			O
IRON SURFACES	⊙					⊙						⊙					O

⊙ Primer and Sealer may be necessary on raw surfaces.

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INDOORS	FLAT PAINT	SEMI-GLOSS PAINT	ENAMEL	RUBBER BASE PAINT (NOT LATEX)	EMULSION PAINT (INCLUDING LATEX)	CASEIN	INTERIOR VARNISH	SHELLAC	WAX (LIQUID OR PASTE)	WAX (EMULSION)	STAIN	WOOD SEALER	FLOOR VARNISH	FLOOR PAINT OR ENAMEL	CEMENT BASE PAINT	ALUMINUM PAINT	SEALER OR UNDERCOATER	METAL PRIMER
PLASTER WALLS & CEILING	⊙	⊙		○	○	○											○	
WALL BOARD	⊙	⊙		○	○	○											○	
WOOD PANELING	⊙	⊙		○	⊙		○	○	○		○	○						
KITCHEN & BATHROOM WALLS		⊙	⊙	○	○												○	
WOOD FLOORS								○	○	⊙	⊙	○	⊙	⊙				
CONCRETE FLOORS									⊙	⊙	○			○				
VINYL & RUBBER TILE FLOORS									○	○								
ASPHALT TILE FLOORS										○								
LINOLEUM								○	○	○			○	○				
STAIR TREADS								○			○	○	○	○				
STAIR RISERS	⊙	⊙	⊙	○			○	○			○	○						
WOOD TRIM	⊙	⊙	⊙	○	⊙		○	○	○		○						○	
STEEL WINDOWS	⊙	⊙	⊙	○												○		○
ALUMINUM WINDOWS	⊙	⊙	⊙	○												○		○
WINDOW SILLS			⊙				○											
STEEL CABINETS	⊙	⊙	⊙	○														○
HEATING DUCTS	⊙	⊙	⊙	○												○		○
RADIATORS & HEATING PIPES	⊙	⊙	⊙	○												○		○
OLD MASONRY	○	○	○	○	○	○									○	○	○	
NEW MASONRY	⊙	⊙	⊙	○	○										○		○	

⊙ Primer and Sealer may be necessary on raw surfaces.

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2. Titanium lead-zinc -- consists of more mineral spirits and driers. T.L.Z. paints tend to chalk easy to insure constant whitening, therefore, colors may present a problem by fading quicker.

3. Titanium zinc -- is less expensive than those containing lead. Where industrial gases may tend to discolor the lead, T.Z. paint may be the answer.

4. Latex paint -- may be a synthetic rubber, vinyl or acrylic. The solvent is water instead of turpentine or mineral spirits. At first they were limited to interior use, however improvements have been made to provide:

a. easier application
b. use on damp surfaces
c. use on exterior
d. ease of cleaning equipment

5. Water thinned powders are commonly used where the lasting quality is not paramount. Calcimine, whitewash and portland cement are all mixed with water and applied with a special wide bristle brush. Successful application is usually over masonry or block work.

6. Metal primers are used to help prepare the metal surface for a final coat or two of enamel or aluminum. Some primers contain acid to etch the surface thereby creating a good bond. Rust inhibitors are also added to most metal primers and metal paints.

7. Porch and Deck paint are usually oil based paint with a varnish-like finish creating a hard wearable surface that resists scuffing, scratching and peeling.

8. Special ingredient paints are those that contain mildew and fire resistant qualities and insect repelling ingredients.

INTERIOR

1. Latex paints -- are most pppular today because of their odorless, fast drying qualities.

2. Flat alkyds -- are also popular for their coverage and ease of application (dripless). These also are very washable and can be applied to all interior surfaces including metal. Water is the solvent for latex and alkyd paints.

3. Enamels and semi-gloss paints -- are very desirable for wood trim, doors windows, etc. They may be obtained in colors to exactly match the flat wall paints or in very vivid greens, reds, blues, etc. Theysolvent for enamels is turpentine.

4. Shellac -- is an old finish made from the Lac Bug, found in India. Because of its transparent quality it is used where wood is exposed. If moisture is a problem, shellac should not be used as it may become cloudy. Shellac is fast drying and has good penetrating qualities, therefore it is often used as a sealer of raw wood before varnishing or painting. Alcohol is the solvent for shellac.

5. Varnish -- is a high quality hard gloss finish. It is made from gum, resins and oils. Varnish drys slowly, therefore, dust may create a problem, Turpentine is the solvent for varnish.

6. Stains -- come in three varieties; oil, water, and spirit. Oil and spirit stain has good penetrating qualities and is more expensive than water stain. Water stain is a mixture of aniline dyes and hot water, however, it will raise the grain on the wood and has a tendency to fade after drying.

7. Varnish stain -- is a combination of an oil stain and varnish. The principle advantage is that staining and varnishing can be done in one operation.

8. Special types of finishes -- include the epoxies, plastics, methane, etc. These finishes usually come in two separate containers and must be mixed just prior to application. They are expensive and somewhat more difficult to apply, however durability and color fastness make them very satisfactory.

9. Spray paint. Not many years ago spray painting was left to the professionals in manufacturing appliances, toys, cars, etc., however with the advent of the compressed gas can everyone can obtain a professional-like finish. The technique of spraying is discussed on page 154 . All types of colors and finishes are available in spray cans.

B. TOOLS AND EQUIPMENT

The actual task of painting or repainting any object or structure from the "time involved" standpoint is very minor, however, the time involved in "preparation" may be considerable. To do any painting job right, certain tools and equipment must be available. The list that follows does not include all items necessary for furniture refinishing, auto painting, appliance refinishing, etc. The custodian may be called upon to paint or repaint a plaster wall, masonry wall, floor, shelves, woodwork, etc. With this approach in mind, consider the following list.

1. Drop cloth.
2. Variety of brushes. See Figure 402.
3. Scraper. See Figure 403.

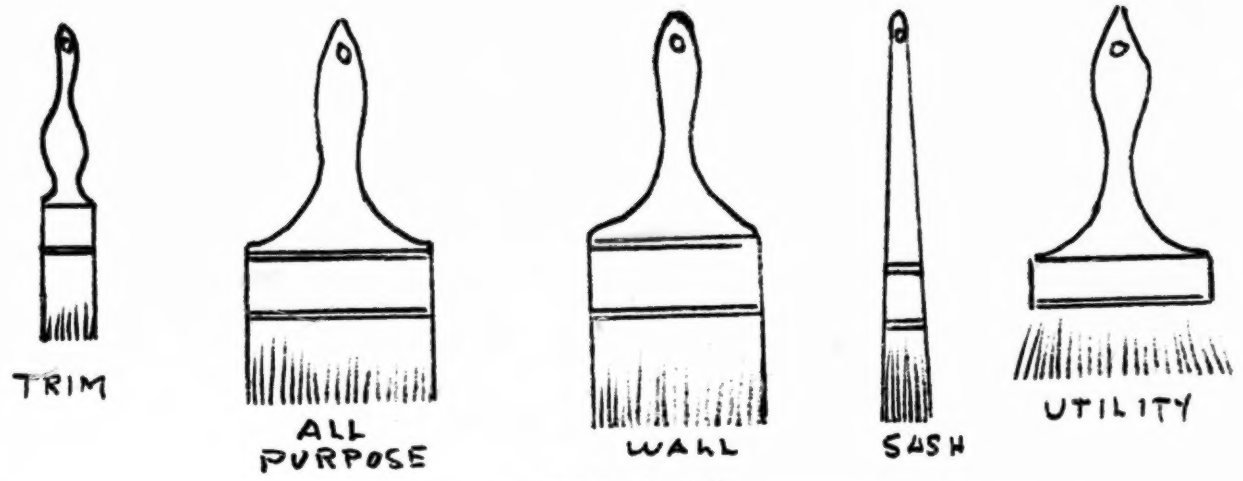

TRIM
ALL PURPOSE
WALL
SASH
UTILITY

FIG 402

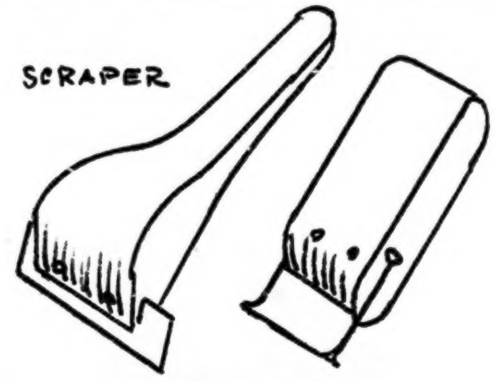


FIG 403

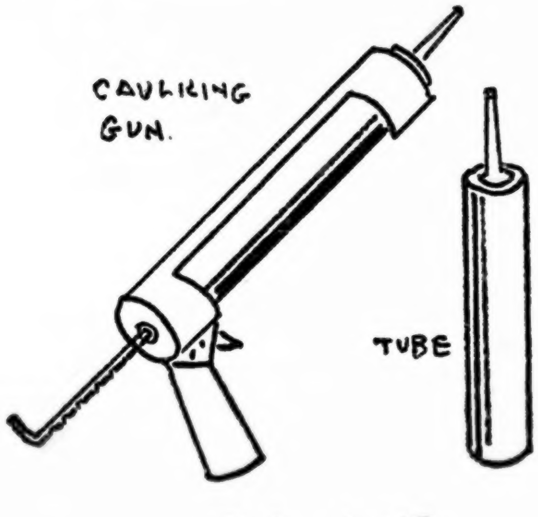

CAULKING GUN.
TUBE

FIG 405

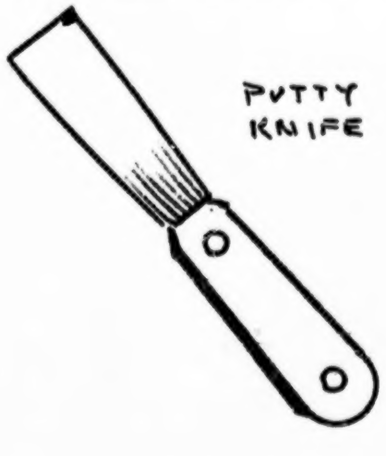

PUTTY KNIFE

FIG 404

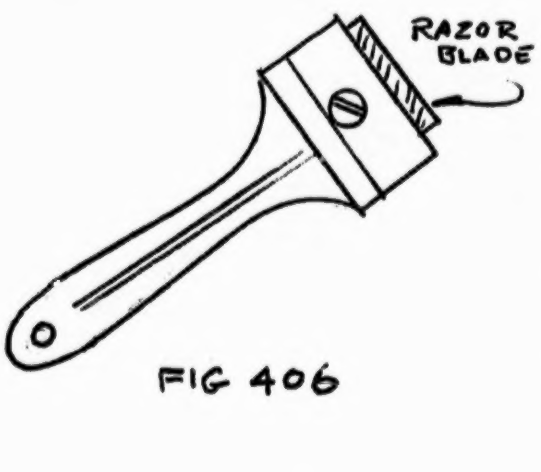

RAZOR BLADE

FIG 406

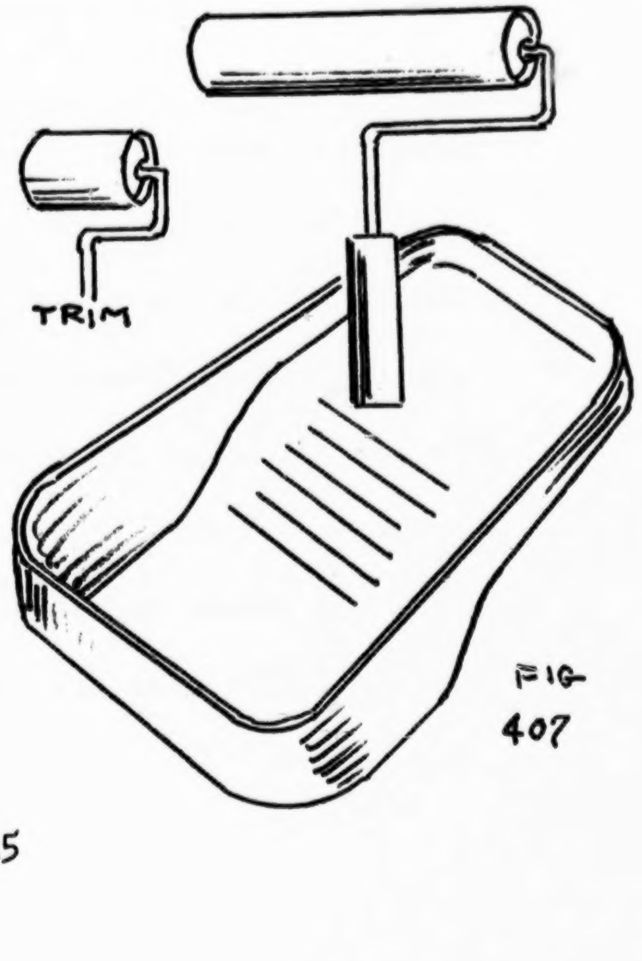


FIG 407

4. Putty knife. See Figure 404.
5. Wodd filler, caulking compound. See Figure 405.
6. Rags.
7. Solvent.
8. Glass scraper and cleaner. See Figure 406.
9. Newspaper and masking tape (if spray is used).
10. Roller and pan (if used). See Figure 407.

C. JOB PROCEDURE

To select type of paint:

1. Consult table on page 141.
2. Consult with authorities on proper colors for schools. (county offices, principals, etc.)

To prepare and repaint a plaster wall:

1. If water damaged, the leak should be repaired first.
2. Remove all hardware (switch plates, outlet covers, etc.)
3. Remove all loose and scaled paint or plaster.
4. Seal all cracks and joints with patching plaster. See Figure 408.

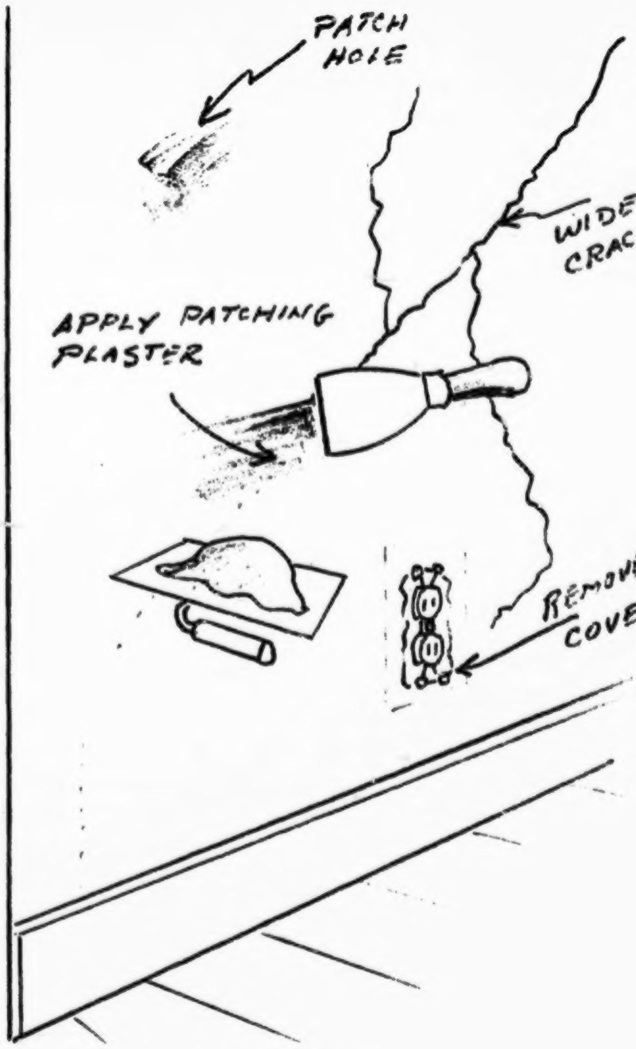


FIG. 408

5. Sand all repairs so that the surface is smooth and even.
6. Sweep up area.
7. Wipe wall down with a damp rag if latex paint is to be used. (Mineral spirits if oil paint is used.)
8. Lay down a drop cloth and cover all stationary fixtures (radiators etc.).
9. Open can of paint and mix thoroughly (stir).
10. Use a step ladder with a shelf attached.
11. If a roller is used--"cut in" with a brush 2" from ceiling, corners and woodwork.
12. Place brush in solvent.
13. Start at the ceiling and work down. (Roll in vertical strokes--brush in horizontal strokes and finish in vertical strokes)feather edges. See figure 409.

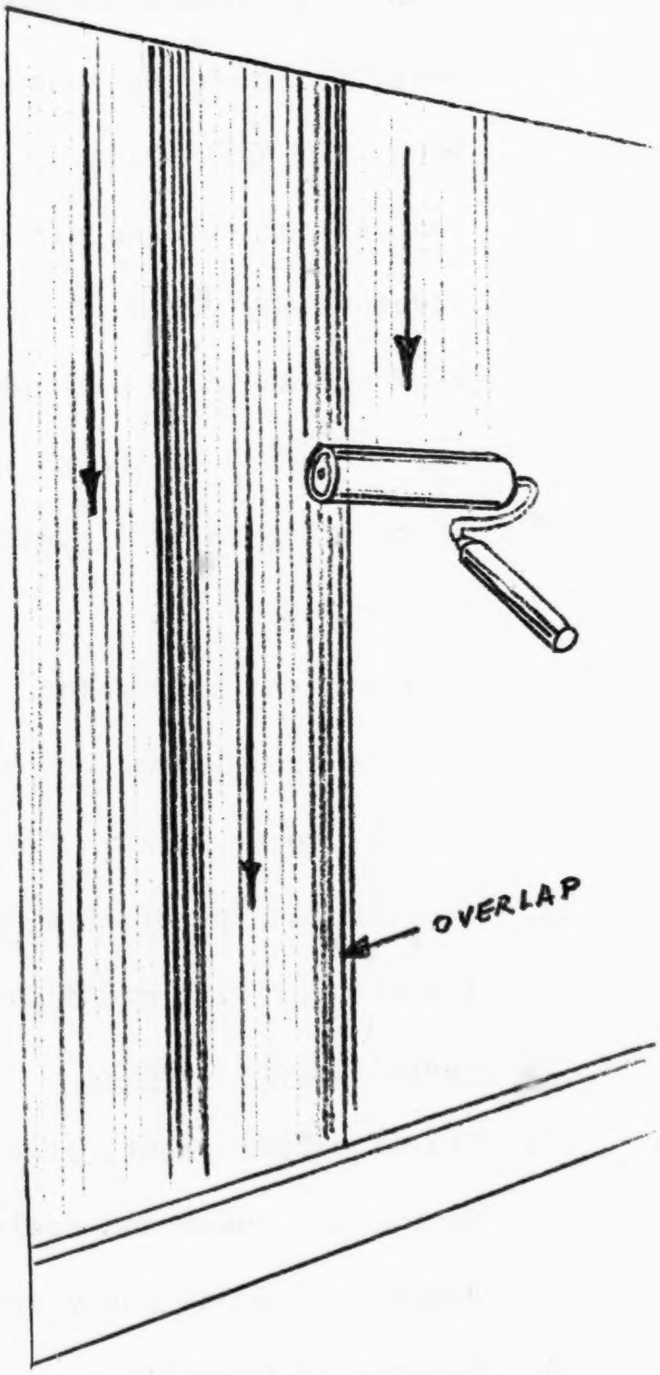


FIG. 409

To repaint woodwork:

1. Select type of paint from table on page 141.

2. Remove all scaled and loose paint.
3. Reset all loose nails and/or drive new finish nails.
4. Wood fill nail holes.
5. Sand all of surface especially if the previous paint is enamel. (Feather any edges of heavy chips removed.)
6. Wipe surface down with proper solvent.
7. Lay down drop cloth and cover permanent fixtures.
8. If color is to be a complete change, a prime coat of white may be advisable.
9. Open can and stir paint. Make sure pigment and solvent is thoroughly emulsified. DO NOT SHAKE ENAMEL.
10. Select proper brush. See figure 402.
11. Starting at top of trim, paint with the length of the wood (careful of wall and floor around shoe mold).

To repaint a wood window:

1. Select proper paint, page 140 .
2. Remove all loose and scaled paint.
3. Remove all loose putty around window glass.
4. Reputty if necessary.
5. Look for dry or wet rot or termite damage and assess the repair.
6. Caulk or recaulk around complete window.
7. Wipe complete window down to remove dust.
8. Select proper brush. See figure 402.
9. If much wood is exposed, a primer coat may be necessary.
10. Paint the smaal strips first then the cross rails. Do trim

and casings last.

11. After paint has set slightly, move window up and down occasionally to prevent binding.

To repaint an exterior masonary wall.

1. Remove all loose and scaled paint from wall.
2. Widen and caulk all masonry and mortar cracks. See figure 410.

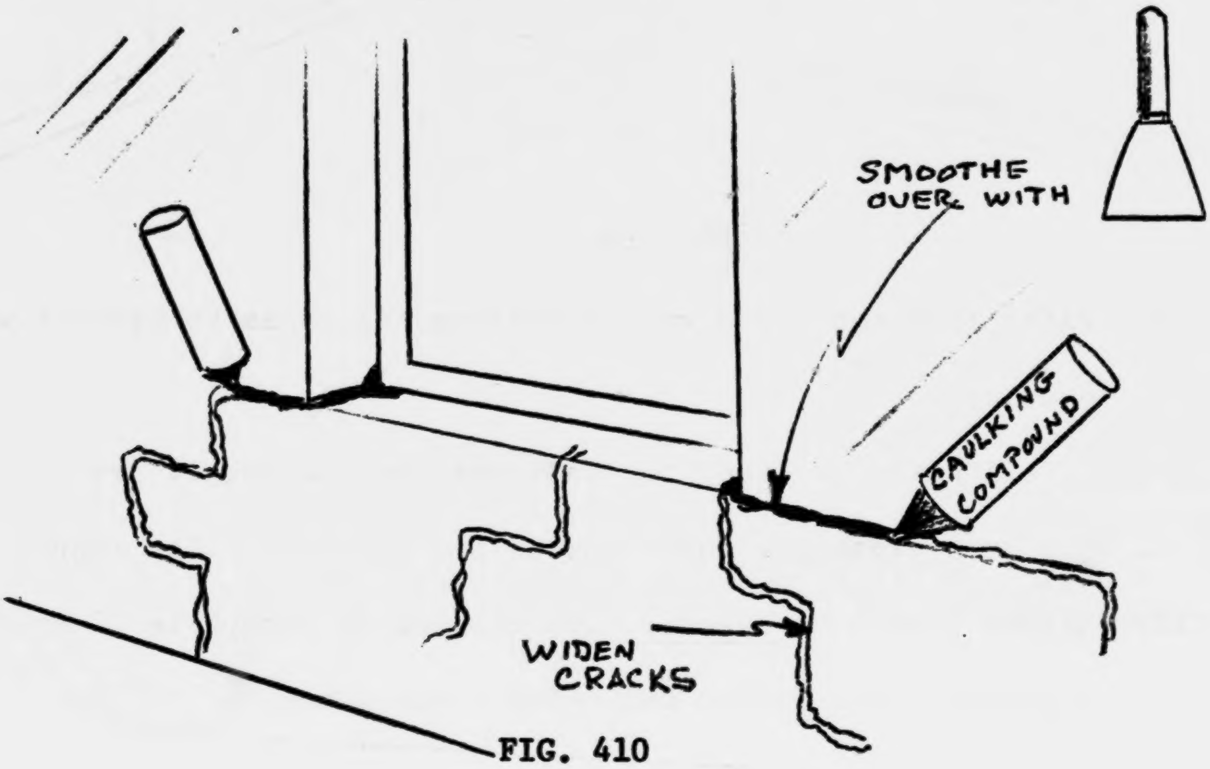


FIG. 410

3. Stiff brush wall to remove excess powdering and dust.
4. If water based paint is to be used, hose down the wall to dampen the surface.
5. Mix paint thoroughly--keep stirred.
6. If a roller is to be used--"cut in" all corners, edges, and around windows. See figure 411.

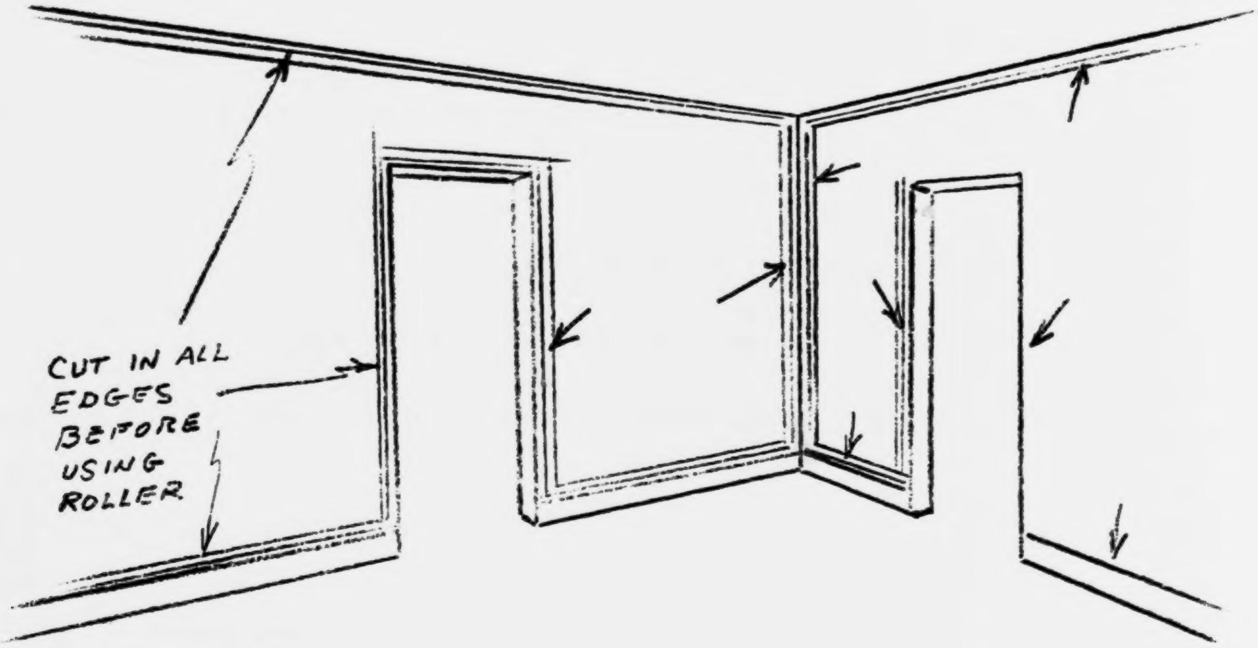

CUT IN ALL EDGES BEFORE USING ROLLER

FIG. 411

7. Paint from the top down, feathering the edges to prevent visual overlaps.
8. If oil paint is used, the wall must be thoroughly dry.
9. Use drop cloths to cover shrubs and walkways. See figure 412.
10. Mildew should be removed with tri-sodium phosphate (2 oz. to 1 gallon.) and rinsed well with clear water.

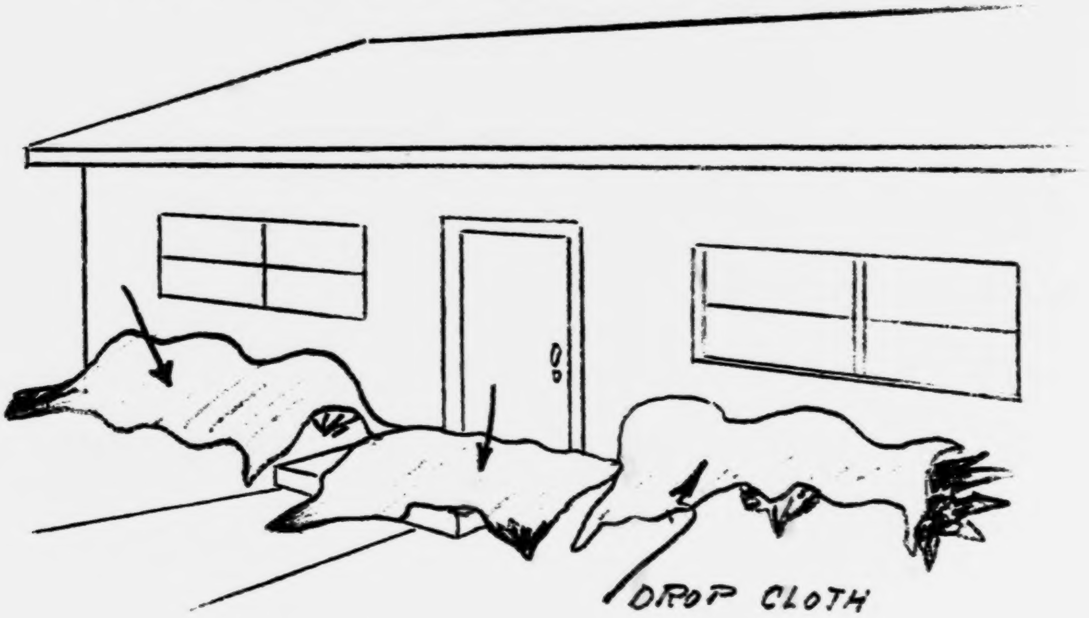


FIG. 412

To apply varnish:

1. Select type of varnish. Page 141.
2. Select brush. See figure 402.
3. Completely wash surface with solvent (turpentine) to remove old oils or waxes.
4. If surface has bare wood, brush on shellac to seal its surface.
5. Rub with steel wool or garnet paper.
6. Brush on first coat of varnish very even and smooth. (may be thinned with turpentine)
7. Allow to dry 24 hrs. and rub down with very fine wet dry sand paper or garnet paper.
8. Brush on second coat of varnish (unthinned) and allow to dry. (48 hrs.)
9. Rub down between each coat except the last coat.
10. Apply a good grade of paste wax and polish (spray wax may be used).

Note: New wood should be sealed with shellac before varnishing (a substitute for shellac could be varnish thinned 1/2)

To apply shellac:

1. Dust surface after sanding all surface and edges.
2. Dilute shellac or varnish 3-1 for first soaking coat - brush on evenly (extra care over knots). See figure 413.
3. Dry one hour and smooth with steel wool.

4. Dilute shellac or varnish 2-1 for second coat - brush on evenly.
5. Dry 8 hrs. and rub down with fine steel wool.
6. Brush on shellac for final coat, and allow to dry 24 hrs.
7. Rub down with fine steel wool and apply a coat of furniture wax.

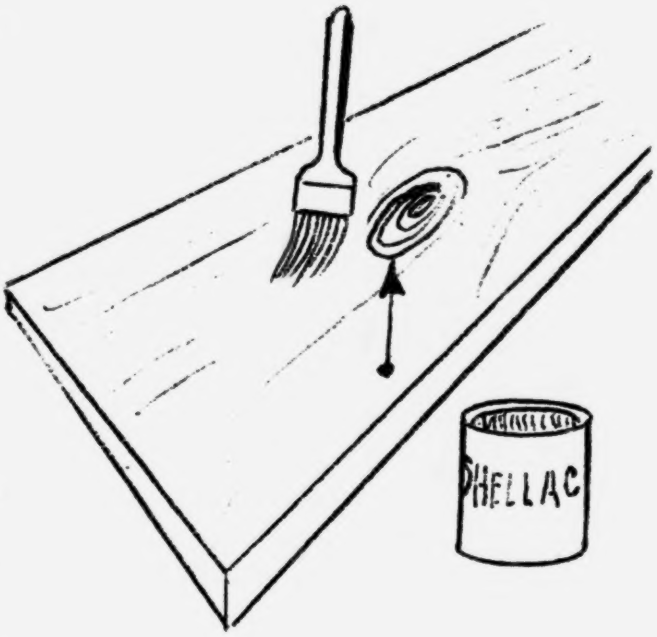


FIG 413

To apply metal finishes:

Actually any good grade of enamel or epoxy can be used on metal surfaces. Many types of corrosive and chemical resistant coatings are manufactured for surfaces exposed to fumes, acid, alkalies, and moisture. Metal coatings may contain lead, zinc, chlorinated rubber etc., and may be applied by brush, roller or spray.

1. Wire brush metal surface to remove loose scale. See figure 414.
2. Scrape stubborn scale until there is no question that the paint that is left is securely bonded. See figure 415.
3. Sand paper or abrase rusted

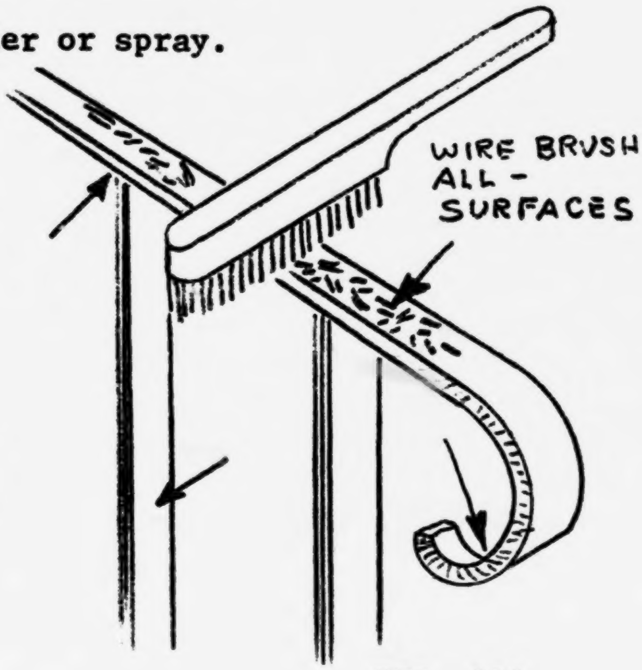


FIG. 414

areas to remove all reddish brown color and leave bright metal. (Feather edges)

4. Wipe thoroughly with the solvent for the paint.
5. Lay down a drop cloth to protect walks etc.
6. Apply a prime coat containing a rust inhibitor and allow to dry thoroughly.

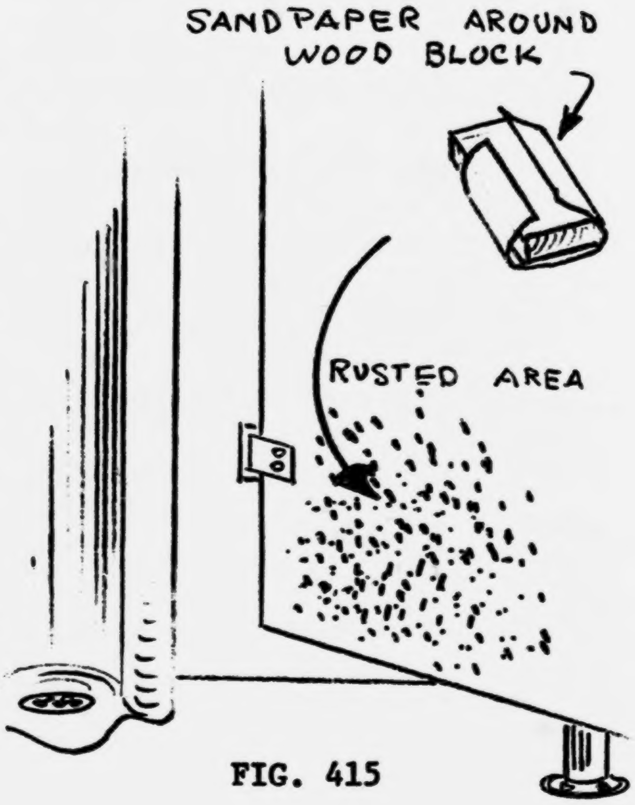

SANDPAPER AROUND WOOD BLOCK
RUSTED AREA

FIG. 415

7. Apply finish coat of corrosion, or chemical resistant enamel or flat paint of the proper color.

Spray painting:

1. Make sure article is clean, smooth and ready for spraying.
2. Mask with tape any parts that are not to be painted.
3. Create a spray area or booth with cardboard or newspaper to contain any overspray. See figure 416.
4. Thin lines, stripes or small areas requiring a different color should be done first.

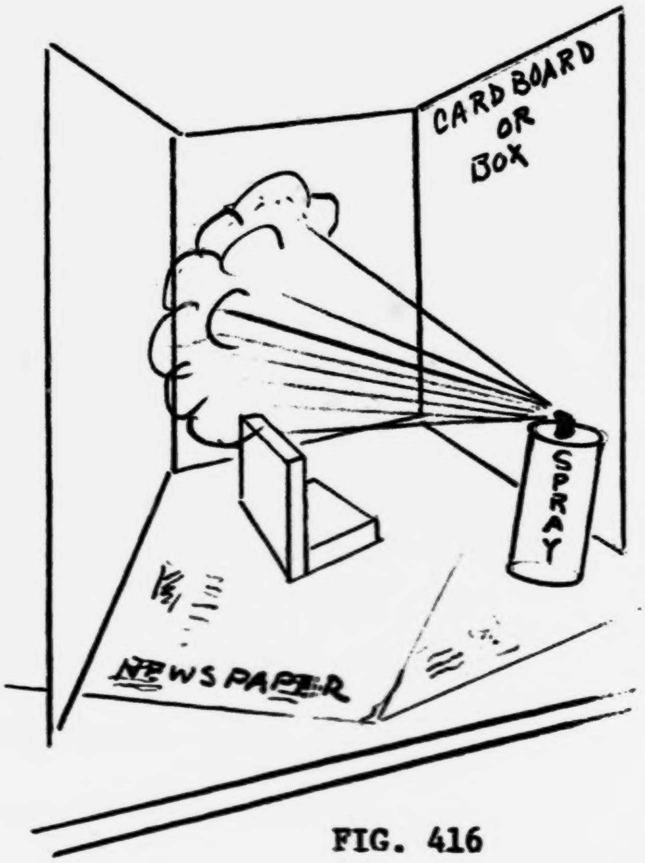
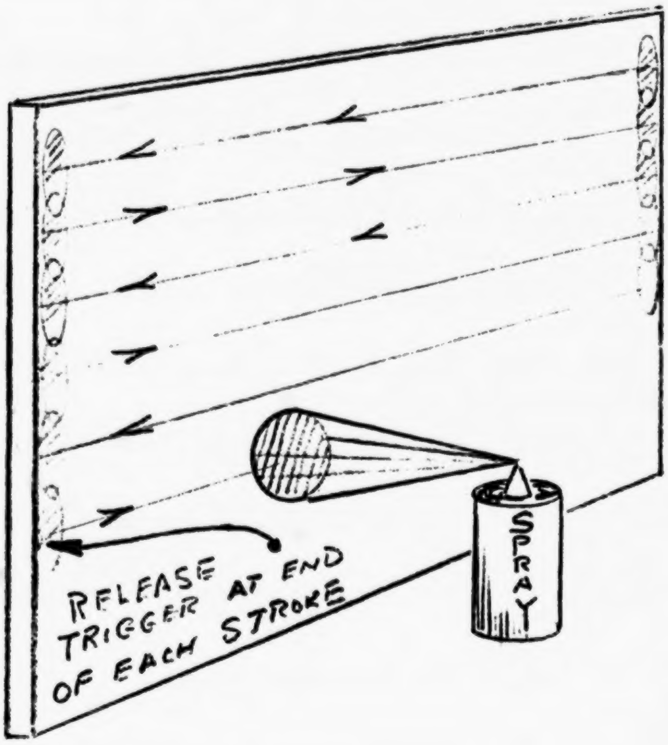

CARD BOARD OR BOX
SPRAY
NEWSPAPER

FIG. 416

(Masking for this operation may not be required)

5. After stripes or lines are thoroughly dry, cut the masking tape and cover the line.
6. Keep nozzle 6 - 9 inches from article.
7. Keep nozzle 90° to surface.
8. Move left to right and back again. (In a straight line, do not arc) See figure 417.
9. Overlap each stroke and release trigger at the end of each stroke to prevent a build up and possible runs.



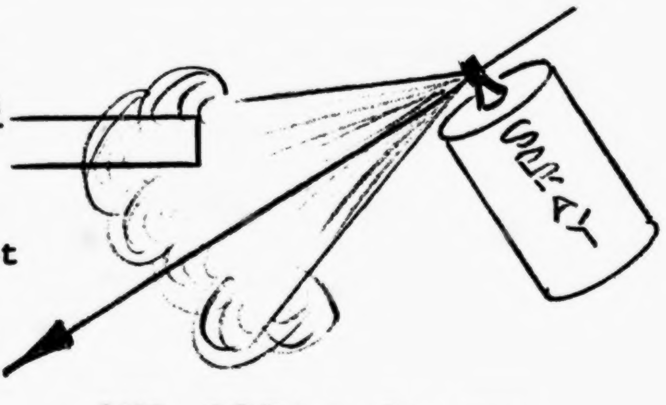
HOLD CAN 6"-9" FROM SURFACE

FIG. 417

10. Go over entire surface once lightly--wait a few minutes for the paint to set and go over again. Repeat until surface shows even density and true color.

Note: Never hold nozzle still on a given spot. Runs will surely result! A thin spot can be covered usually by two sweeping strokes.

Extra Note: When spraying edges, aim the center of the nozzle slightly away from the edge



AIM SPRAY BELOW OR ABOVE EDGE TO PREVENT RUNS AND EXCESS PAINT

FIG. 418

toward the air. See figure 418.

To apply penetrating wood seal:

1. Sweep and scrub floor thoroughly with a good floor cleaner.
2. Allow to dry thoroughly.
3. Select a good penetrating wood seal.
4. Apply one coat of seal with a mop or applicator to worn traffic areas. (Feather edges) See figure 419.

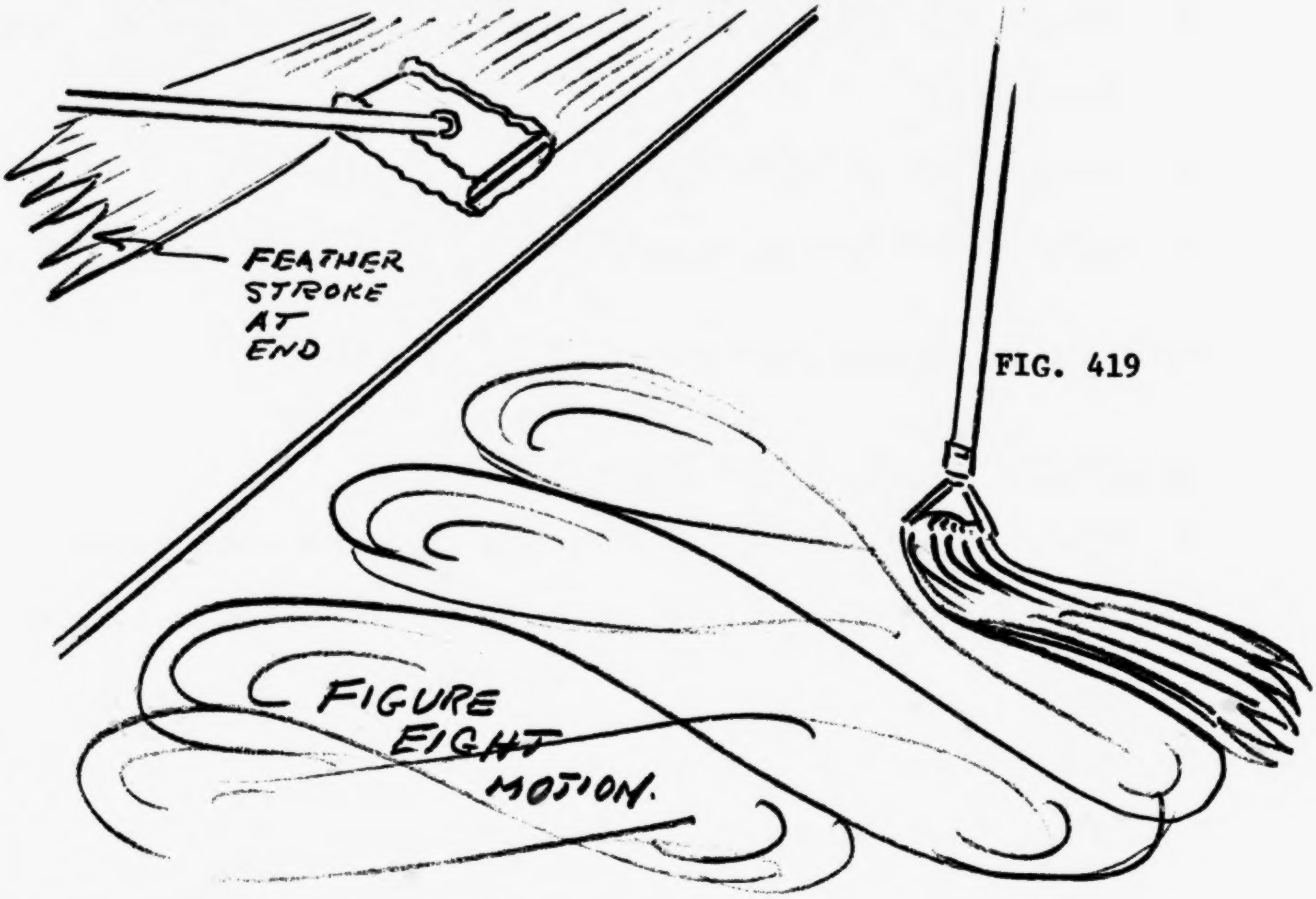


FIG. 419

5. Allow to dry as specified on container.
6. Buff with 3/0 steel wool.
7. Apply second coat, smoothly and evenly, over complete floor with applicator or mop.

8. Buff entire floor with 3/0 steel wool.
9. Apply a coat of floor finish (wax or waxless).
10. Buff if necessary.

__To apply floor varnish or surface seal:__

1. Strip floor with abrasive pad to remove old wax and possibly a portion of the old varnish or surface seal.
2. Vacumm floor to remove all dust.
3. Using a mop or applicator apply one thin coat of finish. (Feather edges)
4. Allow to set at least 48 hrs.
5. Apply second coat as in step #3.

Note: Avoid puddles, and holidays.

__To remove a finish (except floors):__

1. Select a good paint or varnish remover, and a cheap brush.
2. Apply over entire surface until the finish begins to bubble and swell.
3. When surface is softened (10-15 min.) scrape old finish off. Use a scraper or putty knife. See figure 420.
4. Wipe onto old newspapers and dispose of residue.
5. Apply a second coat over stubborn spots and repeat until

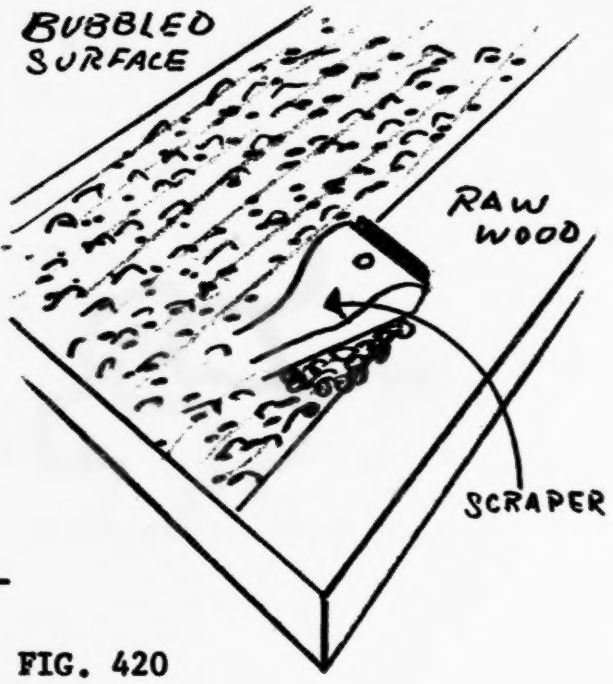


FIG. 420

all finish is removed.

6. Wash surface with turpentine or a neutralizing agent as recommended by the container.
7. Lightly sand the surface and treat as new wood. (Seal surface, with shellac or "cut down" varnish)

Care of tools and equipment:

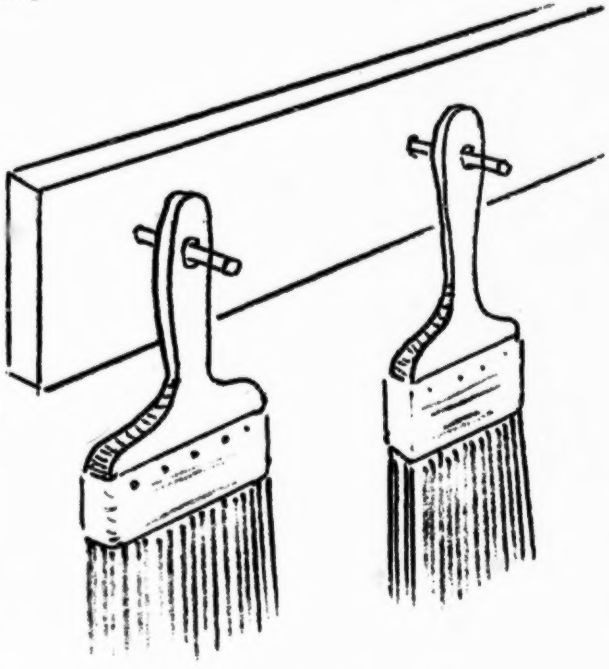


FIG. 421

1. Clean all paint brushes, roller or spray nozzles if used, with the prescribed solvent. i.e., water and soap, turpentine alcohol, benzine etc.
2. Hang all brushes to dry. Drill a hole in handle. See figure 421.
3. After brush is clean, dipping it in kerosene impregnates the bristles and protects the brush.
4. Clean the rim of the paint can before recovering, and seal tightly.
5. Clean all tools (screwdriver, pliers, putty knives, scrapers, etc. before storing.
6. When drop cloth is dry, roll or fold and store away.
7. Wooden ladders should not be painted. Scrape off obvious stains and store properly.
8. Store all flamables in outdoor well ventilated storage areas. Oily rags should be in approved lock-lid containers.

9. **During painting operation and until paint is dry, signs should be posted WET PAINT. See figure 422.**

10. **If possible rope off the area. Traffic should be directed around scaffolding or ladders at a safe distance to prevent spattering etc.**

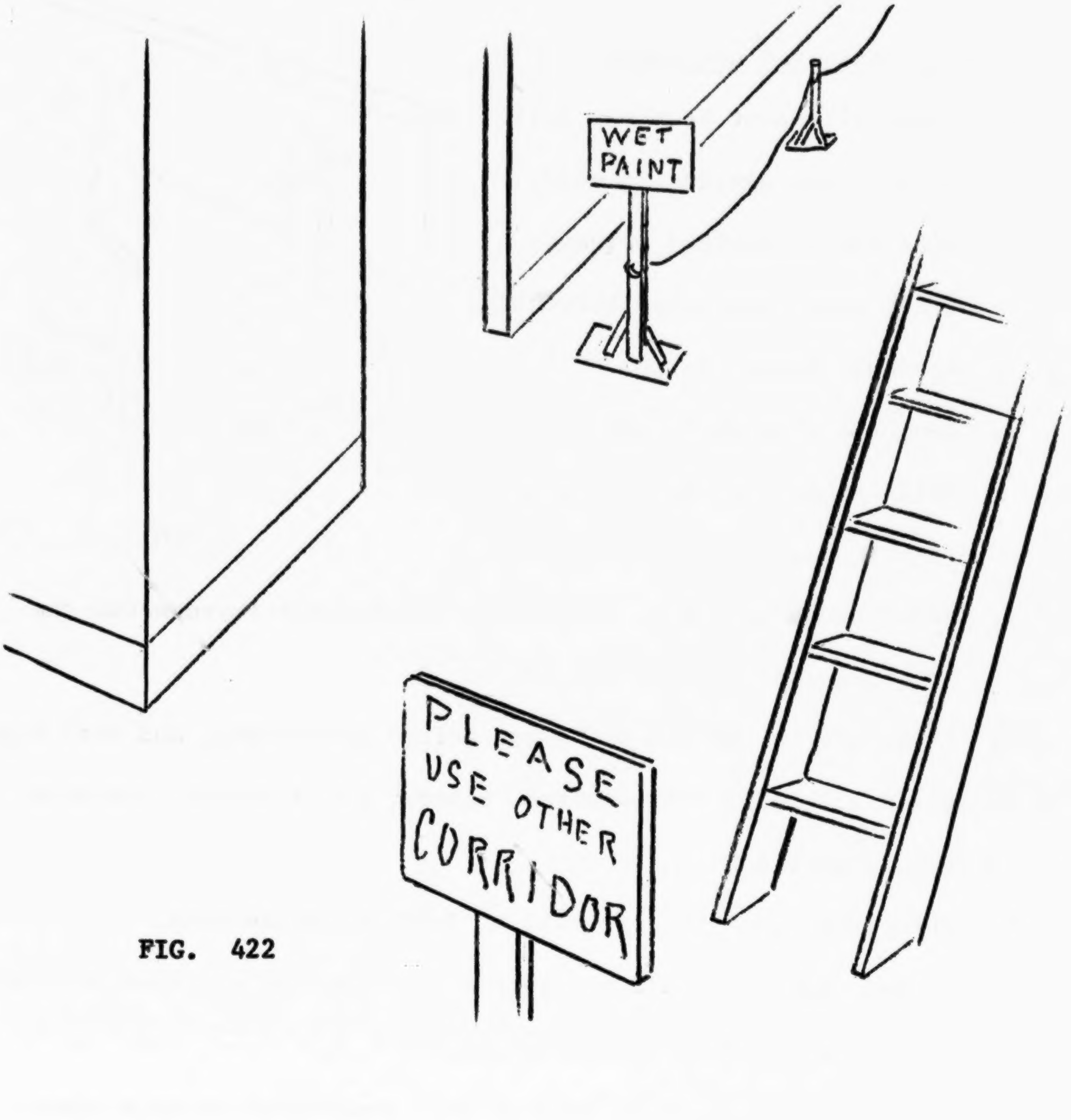

WET PAINT
PLEASE USE OTHER CORRIDOR

FIG. 422

CHAPTER V
MASONRY

DEFINITIONS - MASONRY

ACCELERATOR - Material added to Portland cement concrete during the mixing to hasten its natural development of strength.

ADJUSTABLE CLAMP - Any type of clamping device that can be adjusted to suit the work being done, but particularly clamps used for holding column forms while concrete is poured.

ADOBE - An aluminous earth from which unfired brick are made, especially in the western part of the United States; an unfired brick dried in the sun; a house or other structure built of such materials or clay.

AERATED CONCRETE - A lightweight material made from a specially prepared cement, and used for subfloors. Due to its cellular structure, this material is a retardant to sound transmission.

AGGREGATE - A collection of granulated particles of different substances into a compound, or conglomerate mass. In mixing concrete, the stone, or gravel, used as a part of the mix is commonly called the course aggregate, while the sand is called the fine aggregate.

AIR POCKET - An airspace which accidentally occurs in concrete work.

AMERICAN BOND - A method of bonding brick in a wall whereby every fifth, sixth, or seventh course consists of headers, the other courses being stretchers. This type of bond is used extensively because it is quickly laid.

BACK FILLING - Course dirt, broken stone, or other material used to build up the ground level around the basement or foundation walls of a house to provide a slope for drainage of water away from the foundation.

BALL PEEN HAMMER - A hammer having a peen which is hemispherical in shape; used especially by metal workers and stonemasons.

BASE COURSE - A footing course, as the lowest course of masonry of a wall or pier; the foundation course on which the remainder rests.

BED JOINT - In brickwork, the horizontal joint upon which the bricks rest, also, the radiating joints of an arch.

BLOOM - An efflorescence which sometimes appears on masonry walls, especially on a brick wall. Also a defect on a varnished surface usually caused by a damp atmosphere.

BOND - In masonry and bricklaying, the arrangement of brick or stone in a wall by lapping them upon one another, to prevent vertical joints falling over each other. As the building goes up, an inseperable mass is formed by tying the face and backing together.

BREEZE CONCRETE - A concrete composed of coke breeze, sand, and Portland cement. It is a relatively cheap concrete and nails can be driven into it, but it has inferior fire-resistive properties. Also called *coke breeze concrete*.

BRICK - Block of material used for building or paving purposes. The brick are made from clay or a clay mixture molded into blocks which are then hardened by drying in the sun or baking in a kiln. American-made brick average 2 1/2 x 4 x 8 inches in size.

BRICK CEMENT - A waterproofed masonry cement employed for every kind of brick, concrete brick, tile, or stone masonry, and also in stucco work.

BRICKLAYER'S HAMMER - A tool used by bricklayers for dressing brick. It has both a sharpened peen and a hammer head.

BRICK TROWEL - In masonry, a flat triangular-shaped trowel used by bricklayers for picking up mortar and spreading it on a wall.

BRICK VENEER - A brick facing applied to the surface of the walls of a frame structure, or other types of structures.

BUILDING BLOCK - Any hollow rectangular block of burned clay, terra cotta, concrete, cement, or glass, manufactured for use as building material.

BUTTERING - In masonry, the process of spreading mortar on the edges of a brick before laying it.

BUTTERING TROWEL - In masonry, a flat tool similar to, but smaller than, the brick trowel; used for spreading mortar on a brick before it is placed in position.

CAPPING BRICK - In masonry, brick which are specially shaped for capping the exposed top of a wall.

CEMENT - In building, a material for binding other material or articles together; usually plastic at the time of application but hardens when in place; any substance which causes bodies to adhere to one another, such as Portland cement, stucco, and natural cements; also mortar or plaster of Paris.

CEMENT COLORS - A special mineral pigment used for coloring cement for floors. In addition to the natural coloring pigment obtained from mineral oxides, there are manufactured pigments produced especially for cement work.

CEMENT GUN - A mechanical device used for spraying fine concrete or cement mortar by means of pneumatic pressure. Same as Cement Gun, the trade-mark for a machine used to apply Gunite.

CEMENTING TROWEL - A trowel similar to the plasterer's trowel, but often of a heavier gauge stock.

CEMENT MORTAR - A building material composed of Portland cement, sand, and water.

CINDER BLOCKS - Building blocks in which the principal materials are cement and cinders.

CINDER CONCRETE - A type of concrete made from Portland cement mixed with clean, well-burned coal cinders which are used as coarse aggregate.

COURSE AGGREGATE - Crushed stone or gravel used to reinforce concrete; the size is regulated by building codes.

CODE - Any systematic collection or set of rules pertaining to one particular subject, and devised for the purpose of securing uniformity in work or for maintaining proper standards of procedure, as a building code.

COMMON BOND - In masonry, a form of bond in which every sixth course is a header course, and the intervening courses are stretcher courses. Sometimes varied, so a header bond is used every fourth or fifth course.

COMMON BRICK - Any brick commonly used for construction purposes; primarily made for building and not especially treated for texture or color, but including clinker and overburned brick.

CONCRETE - In masonry, a mixture of cement, sand, and gravel, with water in varying proportions according to the use which is to be made of the finished product.

CONCRETE BLOCKS - In masonry, precast, hollow, or solid blocks of concrete used in the construction of buildings.

CONCRETE INSERT - A type of metal anchor used to secure structural wood parts to a concrete or masonry wall.

COURSE - A continuous level range or row of brick or masonry throughout the face or faces of a building; to arrange in a row. A row of bricks, when laid in a wall, is called a course.

CUBIC CONTENT - In building construction, the number of cubic feet contained within the walls of a room or combination of rooms and used as a basis for estimating cost of materials and construction; cubic content is also important when estimating cost of installing heating, lighting, and ventilating systems.

CURB EDGER - In masonry and cement work, a tool specially designed for shaping curved sections which must be finished smooth and true, such as the borders of driveways or pavements.

DOUBLE FLEMISH BOND - A bond in which both the inner and outer faces of an exposed masonry wall are laid in Flemish bond, with all headers true or full headers.

DUTCH BOND - In masonry, a bond having the courses made up alternately of headers and stretchers.

ECONOMY BRICK - Modular brick related to every four-inch module in height, thickness, and length. Economy brick are always cored brick. Size 3 1/2" x 3 1/2" x 7 1/2".

ENAMELED BRICK - In masonry, brick with an enamel-like or glazed surface.

ENGLISH BOND - In brickwork, a form of bond in which one course is composed entirely of headers and the next course is composed entirely of stretchers, the header and stretcher courses alternating throughout the wall; a type of bond especially popular for use in a building intended for residential purposes.

EXPANSION JOINT - In masonry, a bituminous fiber strip used to separate blocks or units of concrete to prevent cracking due to expansion as result of temperature changes.

FACEBRICK - The better quality of brick such as is used on exposed parts of a building, especially those parts which are prominent in view.

FIELD TILE - A type of porous tile which is placed around the outside of a foundation wall of a building, to absorb excess water and prevent seepage through the foundation.

FIREBRICK - Any brick which is especially made to withstand the effects of high heat without fusion; usually made of fire clay or other highly siliceous material.

FIRE CLAY - Clay which is capable of being subjected to high temperatures without fusing or softening perceptibly. It is used extensively for laying firebrick.

FLAGSTONE - A kind of stone that splits easily into flags, or slabs; also, a term applied to irregular pieces of such stone split into slabs from 1 to 3 inches thick and used for walks or terraces. A pavement made of stone slabs is known as flagging.

FLASHING - Piece of lead, tin, or sheet metal, either copper or galvanized iron, used around dormers, chimneys, or any rising projection, such as window heads, cornices, and angles between different members, or any place where there is danger of leakage from rain water or snow. These metal pieces are worked in with shingles of the roof or other construction materials used.

FLEMISH BOND - A bond consisting of headers and stretchers, alternating in every course, so laid as always to break joints, each header being placed in the middle of the stretchers in courses above and below.

FLOATER - A tool used to smooth and finish cement work.

FLOATING - The process of spreading, plastering, stucco, or cement on the surface of walls to an equal thickness by the use of a board called a float.

FLUSH JOINT - In masonry, a mortar joint formed by cutting surplus mortar from the face of a wall. If a rough texture is desired, the surface of the joint may be tapped with the end of a rough piece of wood after the mortar has slightly stiffened.

FLYING BOND - In bricklaying, a bond formed by inserting a header course at intervals of from four to seven courses of stretchers.

FOOTING FORMS - Forms made of wood for shaping and holding concrete for footings and columns which support beams and girders.

FORMS - In building construction, an enclosure made of either boards or metal for holding green concrete to the desired shape until it has set and thoroughly dried.

FORM STOP - In concrete work, a term applied to a device consisting of a plank nailed to a 4 x 4 placed in the forms at the end of a day's pouring.

FRACTURE - In masonry, the breaking apart or separation of the continuous parts of a wall of brick or stone, caused by a sudden shock or excessive strain.

GARDEN BOND - A type of masonry construction consisting of three stretchers in each course followed by a header. However, this bond may have from two to five stretchers between headers.

GLAZED BRICK - Building brick prepared by fusing on the surface a glazing material; brick having a glassy surface.

GLAZED TILE - A type of masonry tile which has a glassy or glossy surface.

GRANITE - An igneous rock composed chiefly of feldspar but containing also some quartz and mica, used extensively in construction work and for monuments. It is extremely hard and will take a high polish.

GREEN MORTAR - A term sometimes applied to mortar before it has set firmly.

GROUND COURSE - A horizontal course, usually of masonry, next to the ground.

GROUT - A mortar made so thin by the addition of water it will run into joints and cavities of masonry; a fluid cement mixture used to fill crevices.

GUNITE - A construction material composed of cement, sand or crushed slag, and water mixed together and forced through a cement gun by pneumatic pressure. Sold under the trade-mark Gunite.

GYPSUM - A mineral, hydrous sulphate of calcium. In the pure state gypsum is colorless. When part of the water is removed by a slow heating process the product becomes what is known as plaster of Paris, used extensively for decorative purposes.

GYPSUM BLOCKS - A type of building material usually grayish white in color; because of its friable texture it is used only in nonload-bearing partition walls.

HALF BAT - A term applied to one-half of a building brick.

HERRINGBONE BOND - In masonry, the arrangement of bricks in a course in a zigzag fashion, with the end of one brick laid at right angles against the side of a second brick.

HIEARLY CEMENT - A contraction of the more generally used term *high early strength Portland cement or concrete*.

HOLLOW CONCRETE BLOCKS - A type of precast concrete building block having a hollow core.

HYDRAULIC CEMENT - A type of cement which hardens under water.

HYDRAULIC MORTAR - In masonry, a mortar which will harden under water; used for foundations or any masonry construction under water.

IRREGULAR-COURSED - In masonry, rubble walls built up in courses of different heights.

JOINTER - In masonry, a flat steel tool used by bricklayers to form the various types of mortar joints between the courses of bricks upon the face of a wall in pointing, as the V, the concave, and weather joints.

JOINTING - In masonry, the operation of making and finishing the exterior surface of mortar joints between courses of bricks or stones.

KEYSTONE - The wedge-shaped piece at the top of an arch which is regarded as the most important member because it binds, or locks, all of the other members together.

LA FARGE CEMENT - A cement produced as a by-product during the calcination of hydraulic lime. It is nonstaining and is imported. It develops almost as much strength as Portland cement.

LINEAL FOOT - Pertaining to a line one foot in length as distinguished from a square foot or a cubic foot.

LINTEL - A piece of wood, stone, or steel placed horizontally across the top of door and window openings to support the walls immediately above the openings.

MARBLE - Any limestone capable of taking a high polish; used extensively for both interior and exterior finish of buildings; because of the wide range of colors from white to dark gray and brown, marble is much used in architectural work for decorative purposes.

MASONRY - A term applied to anything constructed of stone, brick, tiles, cement, concrete, and similar materials; also, the work done by a mason who works in stone, brick, cement, tiles, or concrete.

MASONRY NAIL - A hardened-steel nail of specialized design, used for fastening wood, etc., to masonry work.

MINERAL AGGREGATE - In masonry work, an aggregate consisting of a mixture of broken stone, broken slag, crushed or uncrushed gravel, sand, stone, screenings, and mineral dust.

MORTAR - In masonry, a pasty building material, composed of sand and lime, or cement mixed with water, which gradually hardens when exposed to the air. Mortar is used as a joining medium in brick and stone construction.

MORTAR BOARD - In masonry, a small square board, with a handle underneath, on which a mason holds his mortar.

MORTAR JOINTS - Joints which represent a wide range of types in finishing the mortar in stone or brickwork.

MOSAIC - A combination of small colored stones, glass, or other material so arranged as to form a decorative surface design. The various pieces are inlaid usually in a ground of cement or stucco.

OLD ENGLISH BOND - In masonry work, a bond consisting of alternating courses of stretchers and headers, with a closer laid next to the corner bricks in every course of headers.

OUT OF TRUE - In shopworking and the building trade, a term used when there is a twist or any other irregularity in the alignment of a form; also, a varying from exactness in a structural part.

PLASTER - Any pasty material of a mortar-like consistency used for covering walls and ceilings of buildings. Formerly, a widely used type of plastering composed of a mixture of lime, sand, hair, and water. A more durable and popular plastering is now made of Portland cement mixed with sand and water.

PLASTER BOARD - A rigid insulating board made of plastering material covered on both sides with heavy paper.

PLASTER LATH - Thin, narrow strips of wood nailed to ceiling joists, studding, or rafters, as a groundwork for receiving plastering.

POINTING - A term used in masonry for finishing of joints in a brick or stone wall.

POINTING TROWEL - A small hand instrument used by stone masons or bricklayers for pointing up joints, or for removeing old mortar from the face of a wall.

PORTLAND CEMENT - A hydraulic cement, commonly used in the building trades, consisting of silica, lime, and alumina intimately mixed in the proper proportions, then burned in a kiln. The clinkers or vitrified product, when ground fine, form an extremely strong cement.

PORTLAND CEMENT PAINT - A specially prepared paint made by mixing cement and water; used on concrete walls as a finish, and to protect the joints against water from rain and snow.

PRESSED BRICK - A high-grade brick which is molded under pressure, as a result of which sharp edges are formed by the meeting of two surfaces and a smooth face, making it suitable for exposed surface work.

PROJECTING BELT COURSE - A masonry term used when referring to an elaboration of a plain band course or cut-stone work projecting beyond the face of a wall for several inches.

PROMENADE TILE - In masonry, unglazed machine-made tile; same as quarry tile.

QUARRY-FACED MASONRY - Squared stone as it comes from the quarry, with split face, only squared at joints having the face left rough as when taken from the quarry, as building stone; masonry built of such stone.

QUARRY-STONE BOND - In masonry, a term applied to the arrangement of stones in rubble work.

QUARRY TILE - In masonry, a name given to machine-made, unglazed tile. Also called promenade tile.

RAKED JOINT - In brick masonry, a type of joint which has the mortar raked out to a specified depth while the mortar is still green.

RAMMER - In building construction, a term applied to an instrument which is used for driving anything by force, as stones or piles, or for compacting earth; in concrete work, a kind of "stomper," used to pack concrete by removing the air bubbles.

RANDOM WORK - Any type of work done in irregular order, as a wall built up of odd-sized stones.

REINFORCED - To strengthen by the addition of new material, or extra material, for the reinforcement of concrete, iron or steel rods are embedded to give additional strength.

REINFORCED CONCRETE - Concrete which has been strengthened by iron or steel bars embedded in it.

ROUGH RUBBLE - In masonry, a wall composed of unsquared field stones laid without regularity of coursing, but well bonded.

ROWLOCK - In masonry, a term applied to a course of bricks laid on edge. Also, the end of a brick showing on the face of a brick wall in a vertical position.

RUSTICS - In masonry, bricks which have a rough-textured surface, often multicolored.

SCRATCH COAT - The first coat of plastering applied to a wall.

SCREEDS - Narrow strips of plaster put on a wall as guides for the workmen. The strips usually are about 8 inches wide with a thickness of two coats of plaster, serving also as thickness guides when applying the remainder of the plastering; also a strip of wood to act as a guide for plaster or concrete work.

SELF-FACED - In masonry, a term applied to stone, such as flagstone, which splits along natural cleavage planes and does not require dressing.

SIEVE - In masonry, a screen or open container with a mesh bottom; used for removing stones and large particles from sand.

SLIP JOINT - In masonry, especially in brickwork, a type of joint made where a new wall is joined to an old wall by cutting a channel or groove in the old wall to receive the brick of the new wall. This method of joining the two walls forms a kind of telescopic, non-leaking joint.

SOLDIER COURSE - In masonry, a term applied to a course of bricks where they are laid so that they are all standing on end.

SPLAYED BRICK - A purpose-made brick having one side beveled off.

STABBING - In masonry a term used when referring to the process of making a brick surface rough in order to provide a key for plasterwork.

STANDARD MODULAR BRICK - A brick, size 2 1/6" x 3 1/2" x 7 1/2", related to the 4 inch module, every 8 inces in height, if the mortar joint is 1/2 inch. Thus, 3 bricks, plus 3 one-half-inch joints, add up to an even 8 inches.

STAR DRILL - A tool with a star-shaped point used for drilling in stone masonry.

STAR EXPANSION BOLT - A bolt or screw having a shield of two semicircular parts which spread apart as the bolt is driven into the shield. Used for securing structural wood parts to a masonry wall.

STRETCHER - In masonry construction, a term applied to a course in which brick or stone lies lengthwise; that is, a brick or stone is laid with its length parallel to the face of the wall.

STRUCK JOINT - In masonry, a mortar joint which is formed with a recess at the bottom of the joint. The struck joint is used extensively, but chiefly for interior-wall surfaces, since it is inferior for outside joints because of its lack of weather-resisting qualities. The recess at the bottom allows water for rain or snow to seep into the wall.

STUCCO - Any of various plasters used as covering for walls; a coating for exterior walls in which cement is largely used; any material used for covering walls which is put on wet, but when dry becomes exceedingly hard and durable.

TERRA COTTA - A clay product used for ornamental work on the exterior of buildings; also, used extensively in making vases, and for decorations on statuettes. It is made of hard-baked clay in variable colors with a fine glazed surface.

TERRAZZO - A type of Venetian marble mosaic in which Portland cement is used as a matrix. Though used in buildings for centuries, terrazzo is a modern floor finish, used also for bases, borders, and wainscoting, as well as on stair treads, partitions, and other wall surfaces.

TESSERA - Any one of the small square pieces of marble, stone, tile, or glass used in mosaic work, such as in floors or pavements.

TILE SETTING ADHESIVES - Specially formulated glues or mastics, used instead of mortar bed, for tile setting, They are said to be clean, waterproof, less expensive, and faster.

TOPPING - A mixture of cement, sand, and water, used in creating the finished surface of concrete work such as walks and floors.

TRIPLE BRICK - A solid masonry unit whose nominal dimensions, which include allowance for the mortar joint described for use with it, are 4" x 5 1/3" x 12".

TROWEL - A flat, steel tool used to spread and smooth mortar or plaster.

TWIN BRICK - Modular brick related to the 4 inch module, every 12 inches in height. Size 2 1/2" x 7 1/2" x 7 1/2". A double-sized brick.

VENTILATING BRICK - A brick which has been cored to provide an air passage for ventilating purposes.

VITRIFIED TILE - In building construction, pipes made of clay, baked hard and then glazed, so they are impervious to water; used especially for underground drainage.

V TOOLED JOINT - In masonry, a mortar joint formed with a special tool. After excess mortar has been removed, the tool is run along the joint.

WATER JOINT - In stone work, a joint protected from rain and snow by sloping the surface of the stone away from the wall, so it will shed water easily.

WATER LIME - A lime or cement which will harden under water; hydraulic cement.

WHITE CEMENT - When a white surface is required, a cement which has been specially burned to make it white is used. This cement has the same qualities as Portland cement.

WIRE TIES - Short lengths of wire in various shapes and gauges for reinforcing the bond between two members. They may be embedded in mortar; nailed, twisted around and between masonry, wood, or metal. Wire ties are usually of cement-coated steel or galvanized metal.

ZONOLITE CONCRETE - A form of concrete which acts as insulation; used as parts of floor slabs for houses without basements.

CHAPTER V
MASONRY

A. UNDERSTANDING MASONRY

For centuries man has used stone as a building material. At first, walls were erected by placing stone on stone without the aid of a binding material. The shape and the tremendous weight of the stones was enough to make the structures quite stable. Early history tells us, however, that man soon learned that by wedging smaller stones in the joint, the heavier stone would set better and leave less holes and cavities. From the wedge came a form of mortar. The Egyptians used Nile mud and straw for both a mortar and the "manufacture" of bricks. This type of clay wall is durable only in areas where there is little or no rainfall. As the technology progressed, the Babylonians and the Assyrians used burnt brick and alabaster slabs. Gypsum and sand were used as a cementious binder.

As near as can be determined lime was first used by the Greeks. The Romans adopted the process of using slaked lime and sand and attained great perfection in its use: Remains today bear out the fine workmanship employed by the Romans. Both the Greeks and the Romans soon found that by adding volcanic ash powder to the lime and sand, a very durable mortar resulted. The excellence of Roman mortar is attributed to the thorough balanced mixture and the ramming and careful application.

The knowledge of this type of mortar carried over into England is basically the same process as used today. The obvious advantage of using mortar over unbound stones is that the stones or brick can be much smaller thereby cutting down on the weight of the structure. Less labor was needed to handle the light bricks and buildings could be made higher.

Modern mortar is made of hydraulic lime, portland cement and sand. Mortar is usually gray in color, however, white mortar is available for special uses. Regulations and usage dictate that mortar must not harden to quickly, must retain plasticity until the bricks are set in place, must not shrink or separate, and must meet the A.S.T.M. (American Society for Testing Materials) specifications. Mortars fall into types (A, B, C, and D) and they are arrived at by the proportions of cementious materials (lime, portland cement, masonary cement) and aggregate (sand). Even the sand used must be of a certain type. All clay must be removed from the sand and each particle has to be "sharp" not rounded like beach sand that has been ground by constant pounding. Mortar is only one phase of the masonry classification; concrete is another mixture and has other uses.

Concrete is a mixture of cement, sand, and rock. Both the sand and the rock is called "aggregate". Sand is fine aggregate and crushed rock is coarse aggregate. When water is added to the proper mixture, the cement and water from a "cement paste". The whole mixture, when properly blended, forms a continuous rock like mass with the sand fitting in the spaces between the rock, and the cement paste holding the entire mass together.

Some structures or conditions require a better quality concrete than others. This is accomplished by:

1. The varying proportions of sand, rock and cement.

2. The size of the aggregate.

3. The amount of water used.

Kinds of Concrete

1. REGULAR CONCRETE is composed of ordinary sand, rock and cement. It is heavy (about 150 lbs. per square ft.), and very durable.

2. HIGH EARLY - STRENGTH CONCRETE hardens very quickly and is more costly. This is used where construction has a deadline and time is important.

3. LIGHTWEIGHT CONCRETE uses an aggregate that is considerably lighter than crushed rock. Cinder is used as the aggregate. A new material called HAYDITE is exceptionably lightweight. Such concrete is used in ceilings and upper floors.

4. GUNITE is applied with a compressed air gun. It is used primarily for repair work and for places that are inaccessible.

5. RUBBLE CONCRETE is a rough concrete, very heavy, and is used for dams, retaining walls, bridge piers etc. The coarse aggregate is large.

Concrete without reinforcing steel is called "plain concrete". When steel is used it is called reinforced concrete. Steel rods are imbedded in the concrete to prevent any cracks from opening and to give greater strength to the sections.

B. TOOLS AND EQUIPMENT

1. Wood float.
2. Steel trowel.
3. Jointer
4. Curb edger.
5. Brick layer trowel.
6. Plumb line.
7. Level.
8. Shovel.
9. Hoe.

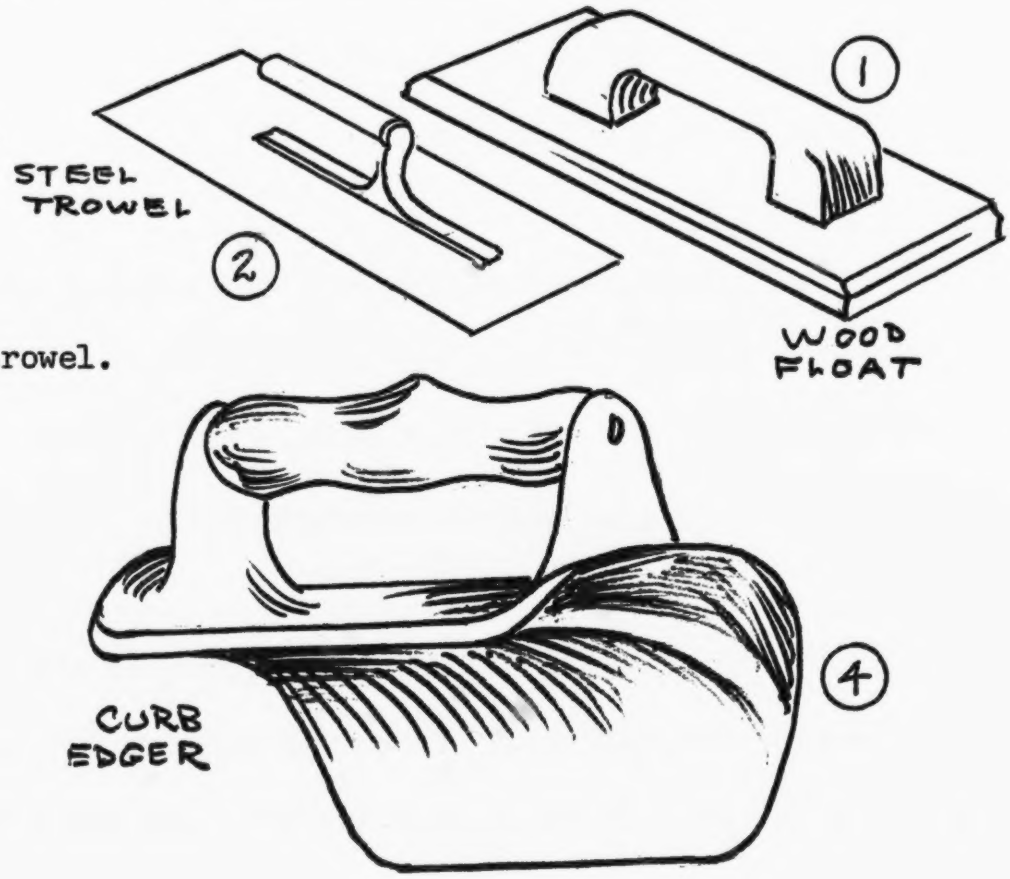

①
WOOD FLOAT
②
STEEL TROWEL
④
CURB EDGER

FIG. 501

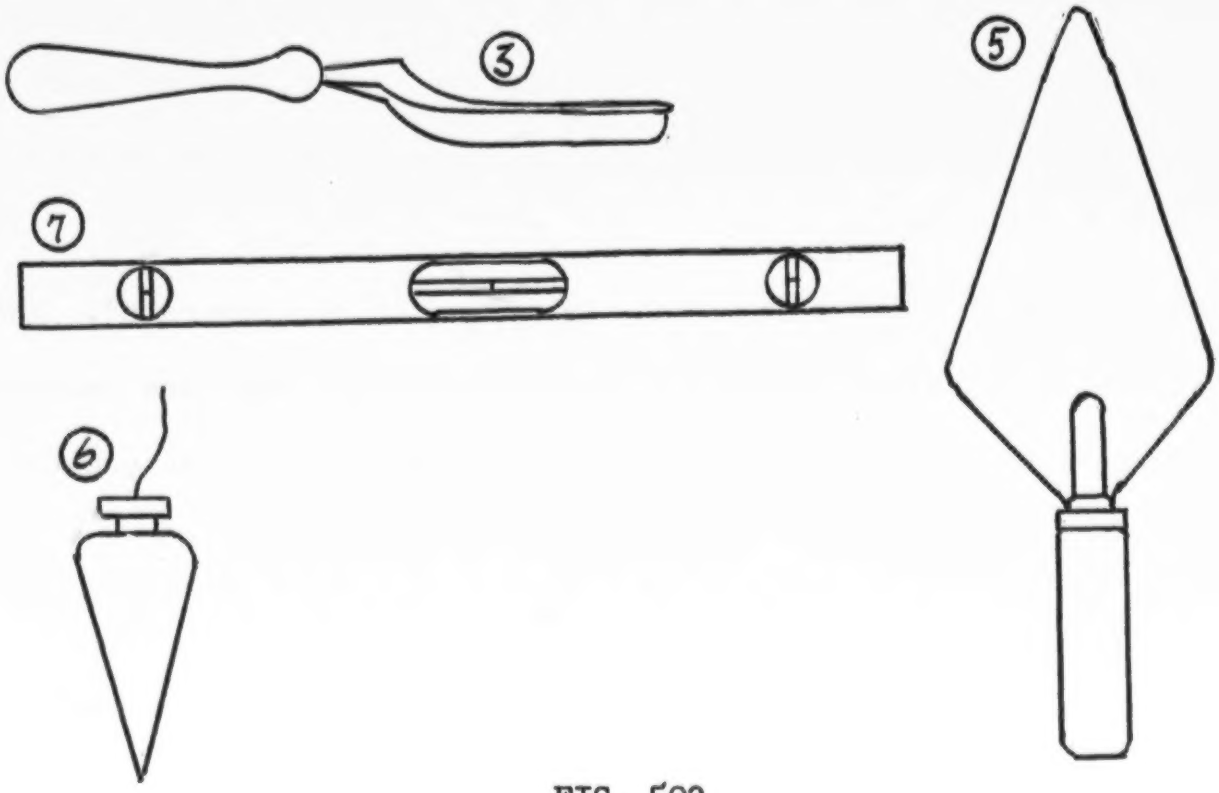


FIG. 502

Table I. Recommended Proportions of Water To Cement and Suggested Trial Mixes

Kind of Work	Add U.S. Gals. of Water to Each Sack of Cement if Sand is			Suggested Mixture for Trial Batch		
	Very Wet	Wet	Damp	Cement Sacks	Sand Cu. Ft.	Crushed Rock or Gravel Cu. Ft.
Five-Gallon Paste for Concrete Subjected to Severe Wear, Weather or Weak Acid and Alkali Solutions						
Colored or plain topping for heavy wearing surfaces and all two-course work for pavements, tennis courts, floors, etc.	Maximum size aggregate 3/8 inch					
	4 1/4	Average sand 4 1/2	4 3/4	1	1	1 1/2
One-course industrial, creamery, and dairy floors and all concrete in contact with weak acid or alkali solutions	Maximum size aggregate 3/4 inch					
	3 3/4	4	4 1/2	1	1 3/4	2
Seven-Gallon Paste for Concrete Not Subjected to Wear, Weather or Water						
Foundations, walls, footings, mass concrete, etc., not subjected to weather, water pressure or other exposure	4 3/4	Average sand 5 1/2	6 1/4	1	2 3/4	4

Table I continued . . .

Six-Gallon Paste for Concrete to be Watertight or Subjected to Moderate Wear and Weather						
	Maximum size aggregate 1 1/2 inch					
Watertight floors such as industrial plant, basement, dairy barn, etc. . . . . . . Watertight foundations. . . . Concrete subjected to moderate wear or frost action such as driveways, walks, tennis courts, garage floors, etc. . . . . All watertight concrete for swimming and wading pools, bird baths, fish ponds, septic tanks, storage tanks, etc. . . . . . . All base course work such as floors, walks, drives, etc. Steps, chimney caps, blocks, concrete masonry, fireplaces, etc. . . . . All reinforced concrete structural beams, columns, lintels, slabs, residence floors, etc.	4 1/4	Average sand 5	5 1/2	1	2 1/4	3

Note.---- It may be necessary to use a richer cement paste in some cases. For example, a swimming pool ordinarily is made using a 6-gallon paste. However, in strongly alkaline soil a 5-gallon paste should be used.

C. JOB PROCEDURE

To Mix Concrete

1. Select the proper proportions of ingredients from Table I.

2. Mix dry ingredients thoroughly on a large flat container. See figure 503.

3. Add water according to Table I mixing with a hoe as you proceed. See figure 504.

4. Transfer mixture to previously prepared form, by wheelbarrow or shovel etc. within 30 to 45 minutes.

Note: A mechanical mixer may be used instead. See figure 505.

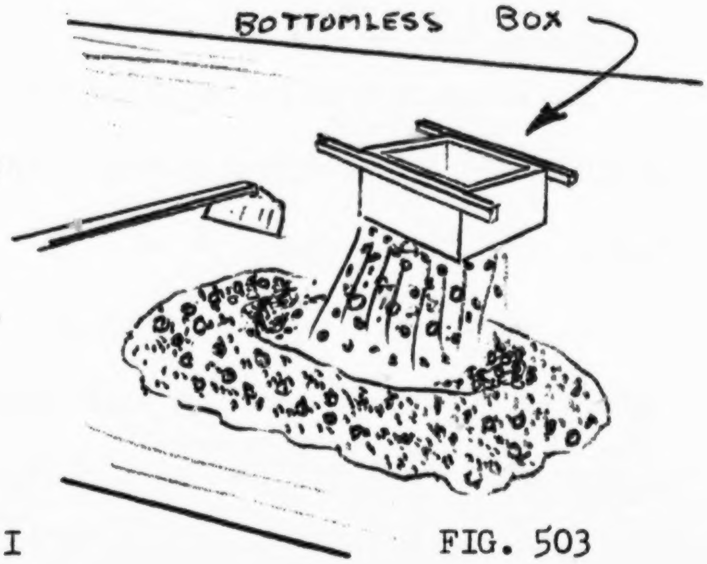


FIG. 503

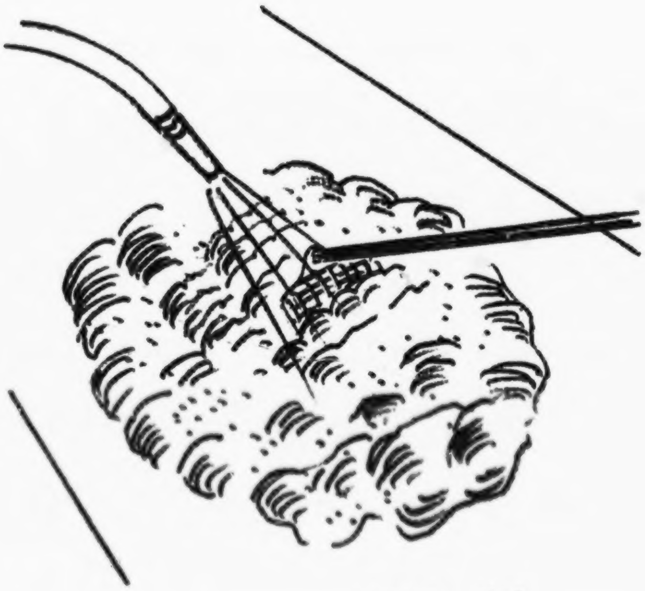
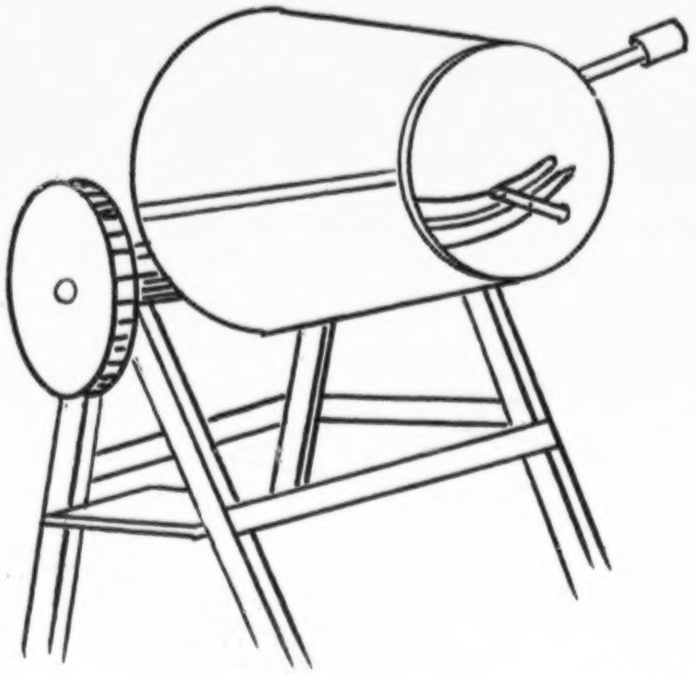


FIG. 504



VSUALLY TWO CUBIC FOOT CAPACITY.

FIG. 505

To Finish a Slab

1. Slab should be at least 4" thick, reinforced with 6x6-#10 road mesh. See figure 506.

2. Level off surplus with a rake and screed the entire slab with a straight edge (2x4 or 2x6), using the forms as a leveling device. See figure 507.

3. Using wide flat boards to kneel on, float the surface to obtain a smooth texture.

4. If a finer texture is desired use the steel trowel. See figure 508.

Note: Using the steel trowel too soon, raises the fine dust like particles to the surface resulting in a powdering effect when set.

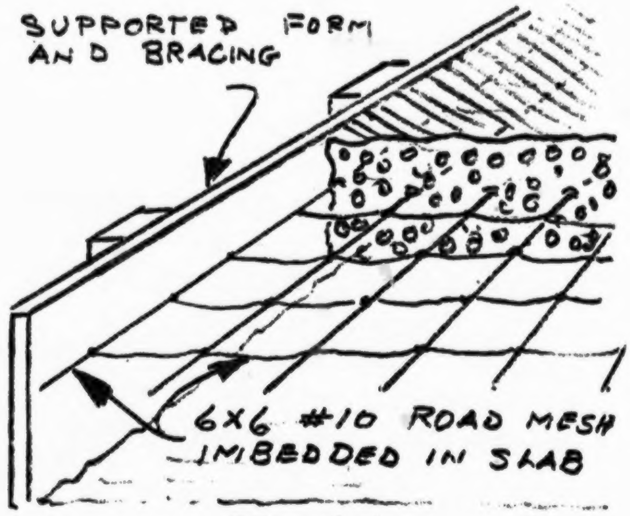

SUPPORTED FORM AND BRACING
6X6 #10 ROAD MESH IMBEDDED IN SLAB

FIG. 506

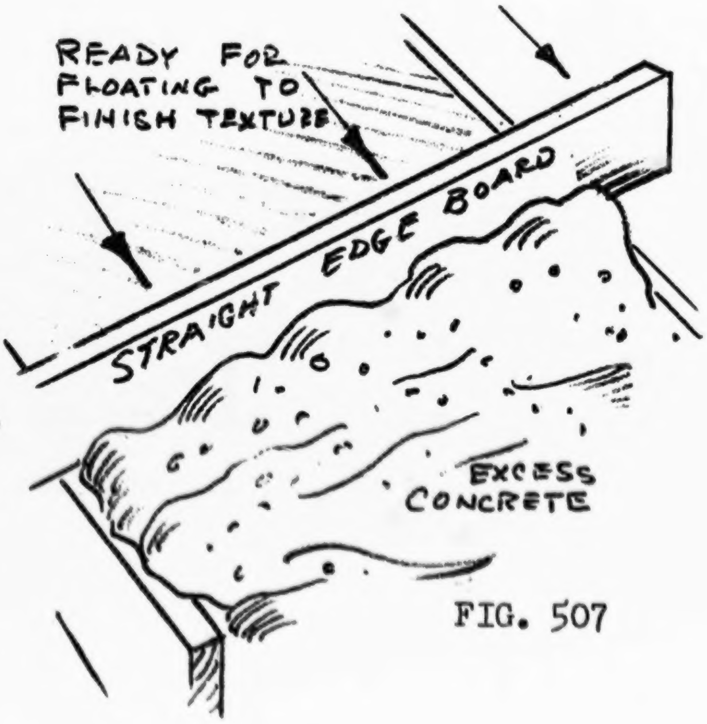

READY FOR FLOATING TO FINISH TEXTURE
STRAIGHT EDGE BOARD
EXCESS CONCRETE

FIG. 507

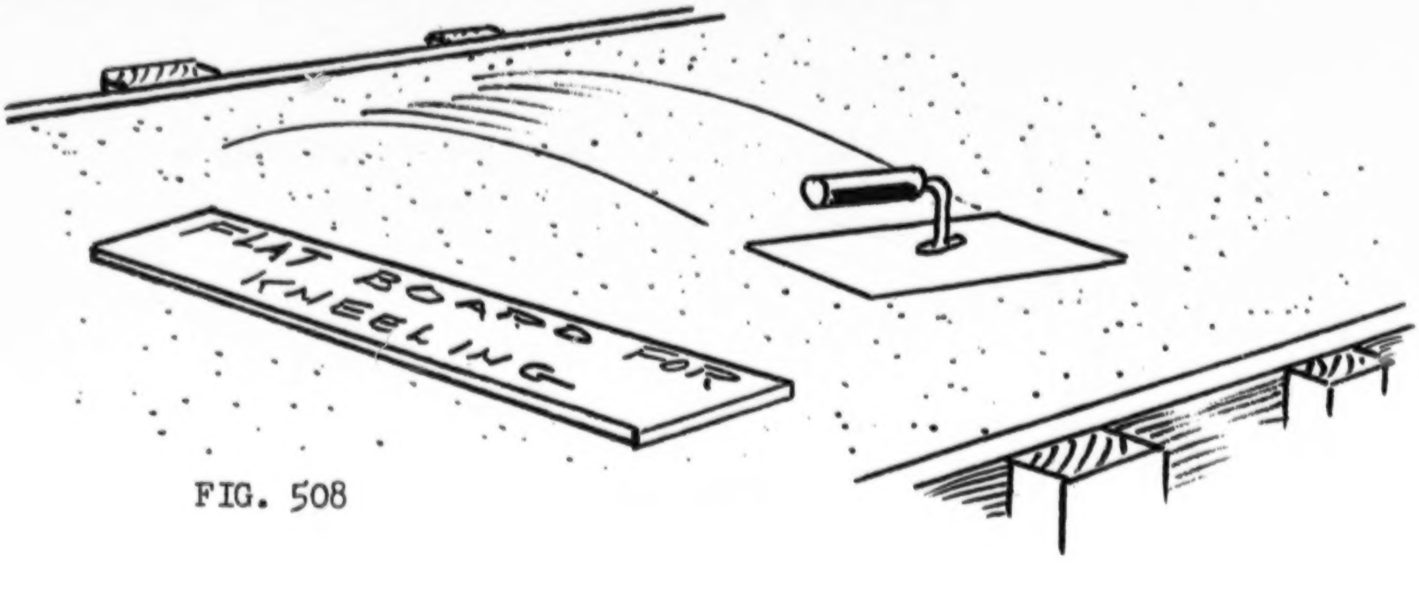

FLAT BOARD FOR KNEELING

FIG. 508

To Cure Concrete

1. Apply wet burlap, canvas or sand on the entire surface as soon as it is set hard enough so marring will not take place.

2. Keep the entire surface wet for several days.

To Set Bricks

1. Select the type brick to be used.

2. Select the type of bond to be used. See figure 512.

3. Mix dry ingredients of the mortar; 2 1/2 to 3 parts, sand to 1 part cement, add water to a good working consistency.

4. Using careful leveling and calculations, "lay in" a line of mortar about 1" thick on the footing. See figure 509.

5. Press bricks into place allowing the mortar to ooze out at the edges. See figure 510.

6. As each brick is ready to set

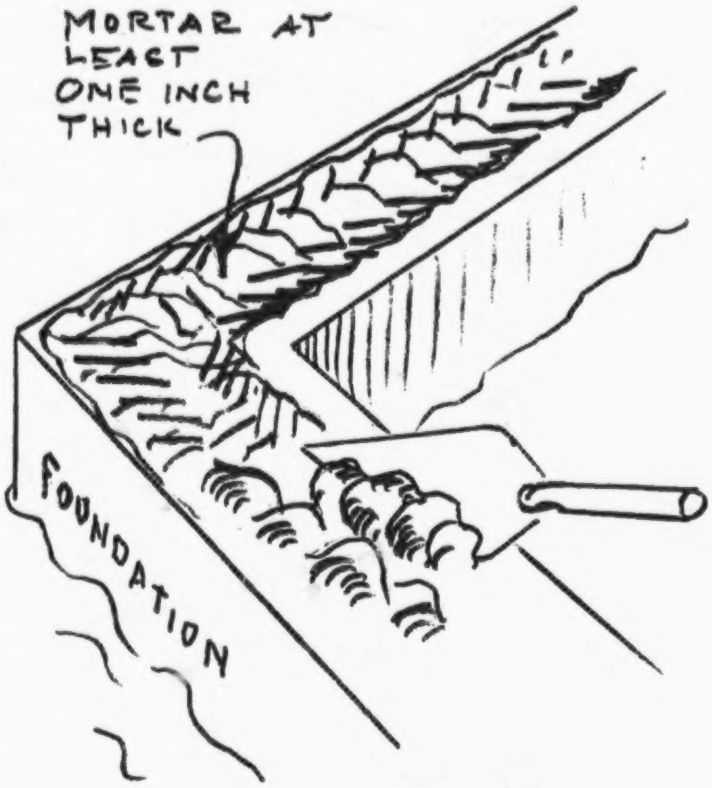


FIG. 509

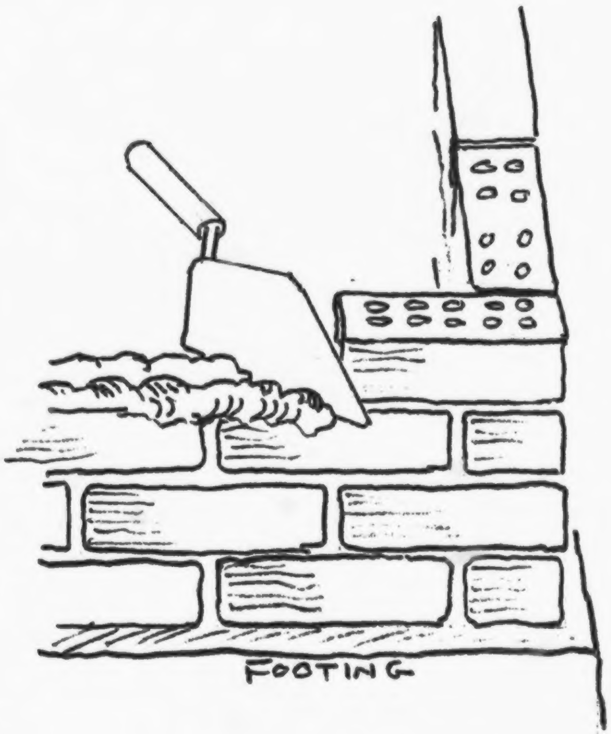


FIG. 510

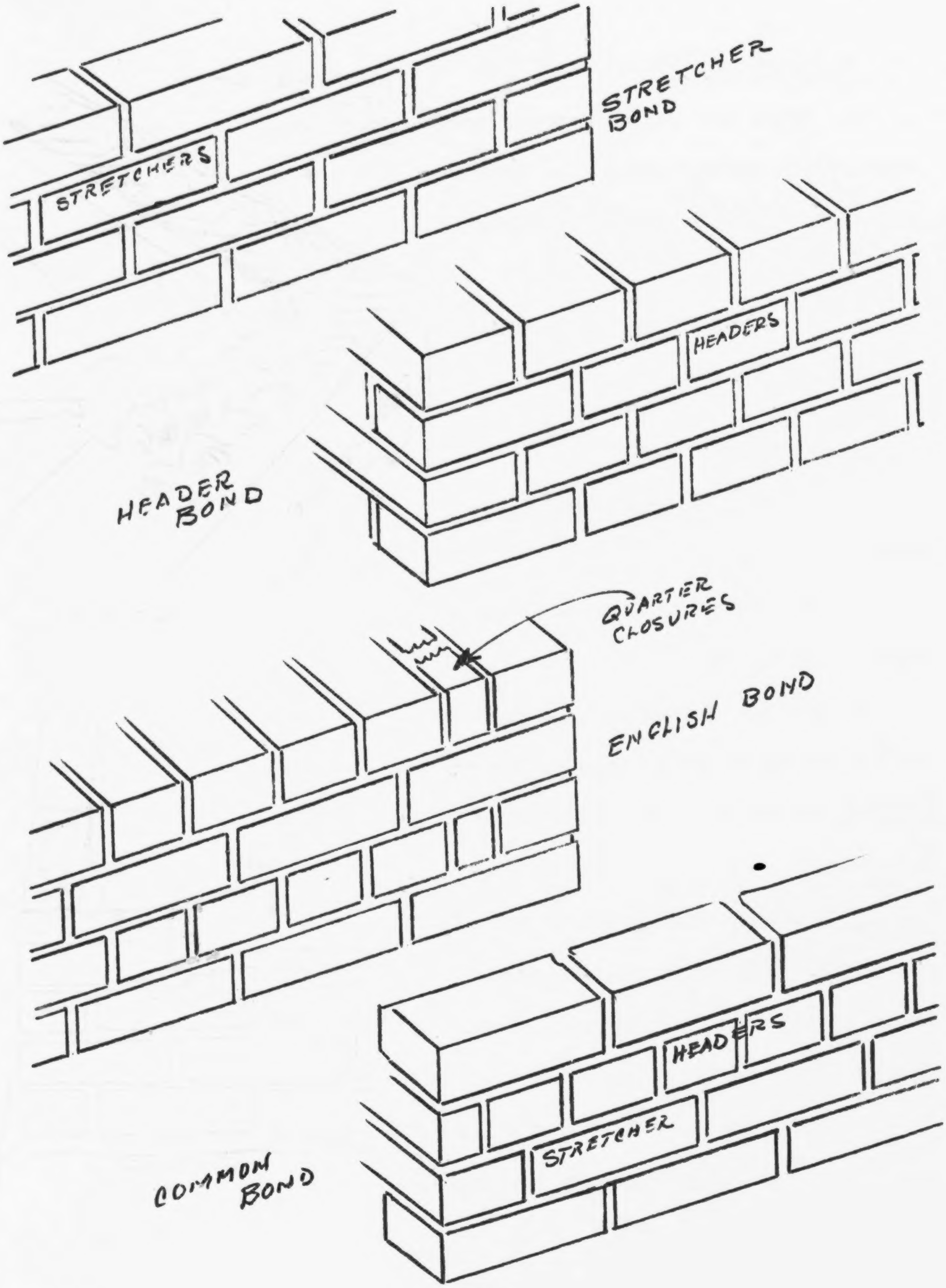

STRETCHER BOND
STRETCHERS
HEADERS
HEADER BOND
QUARTER CLOSURES
ENGLISH BOND
HEADERS
STRETCHER
COMMON BOND

FIG. 511

apply mortar (3/4") to the end butting against the previous brick. See figure 512.

7. Strike the joint with a trowel.

8. "Joint" the courses before the mortar has set. See figure 513.

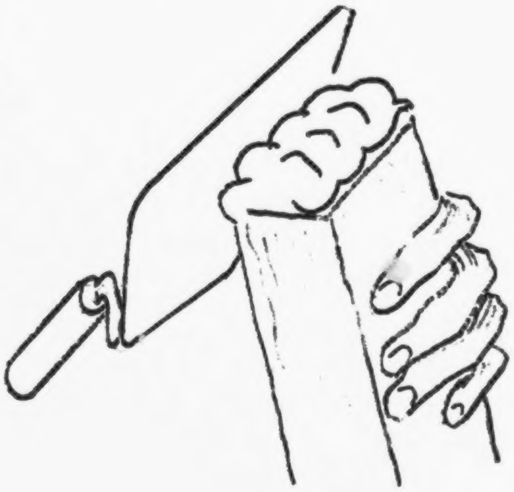


FIG. 512

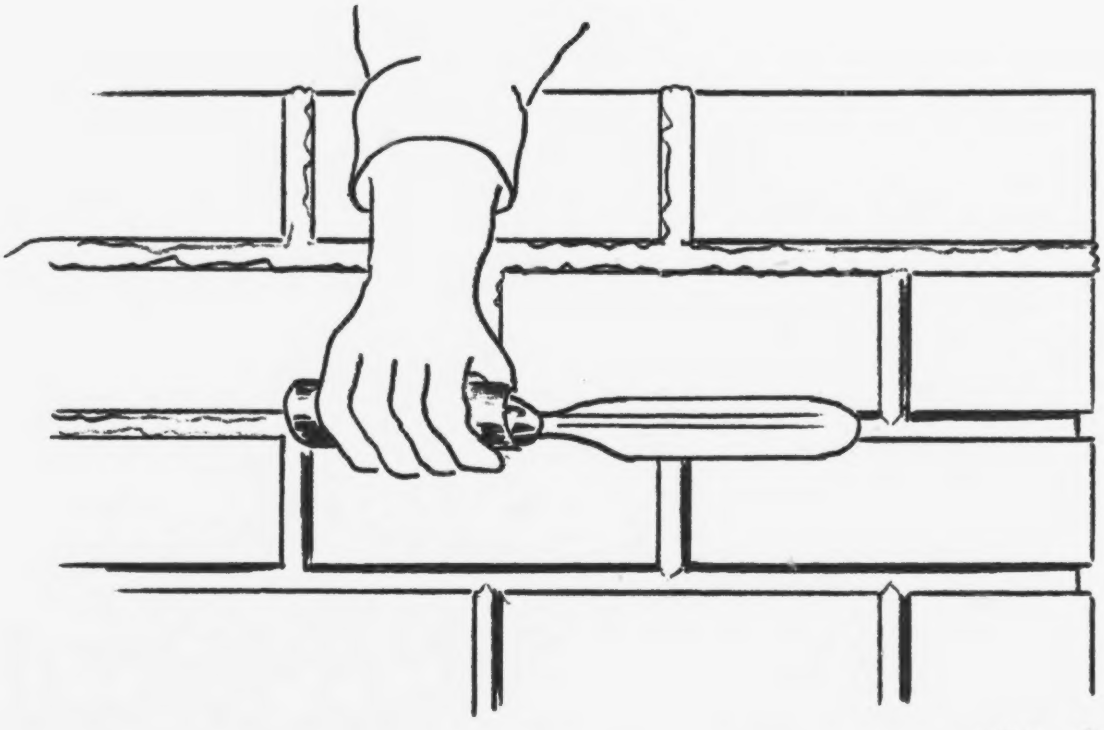


FIG. 513

MISCELLANEOUS INFORMATION AND HELPFUL HINTS

How to Troubleshoot Fluorescent Lamps

Fluorescent lamps can be puzzlers. Besides dying an uncomplicated natural death, they suffer from various ills. Some of the problems may be due to the outside controls required for their operation, but making sure of the tube itself is the first step you should take.

Check the tube. Turn it gently in the socket to be sure the connection is good. Replace it with a lamp that you know is good if it fails to come on.

Check the starter. Replace it with one that you know is good, but make sure it's the proper size. Lamp makers suggest putting in a new starter with every second bulb replacement.

Check the fixture. Be sure the wiring from the lamp holders and starter socket is correct and tight. Watch for shorts, open circuits, and grounds.

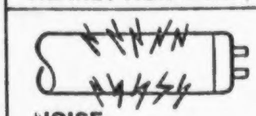
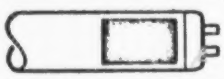
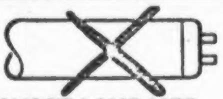
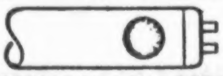
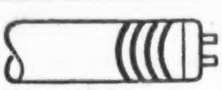
Check the ballast. If the above tests do not remedy the trouble, try another ballast you know is good.

There are peculiarities to watch for with fluorescents. They are fussy about temperature. They put out the greatest amount of light between 70 and 80 degrees. Below that, light output falls off badly. Cool breezes blowing around the fixture may cause erratic operation of the tube.

Obvious differences when a lamp is changed in a two-lamp fixture may be due to the fact that fluorescents are made to be extra bright during the first 100 hours of life. Three shades of white on the market may account for a comparative color difference, too. Changing both paired tubes at once may be a good idea.

When buying a replacement tube, check the etching. In some sizes, you can choose from three types of lamps: Instant Start, Preheat Rapid Start, and Preheat. When making replacements, use a like tube whenever possible. While Preheat Rapid Start tubes will work satisfactorily in most fixtures designed for Preheat tubes, Instant Start tubes will burn out the ballast or fail to light in circuits designed for different tube types.—*Phil McCafferty.*

FLUORESCENT-LAMP CHECK LIST

SWIRL OR FLICKER	1. Starter near end of life. 2. Wrong ballast. 3. New lamp may flicker, should improve as lamp ages.
BLINKING OF NEARLY NEW LAMP	1. Low temperature; cold draft hitting lamp. 2. Defective tube. 3. Defective starter. 4. Loose contact. 5. Voltage low.*
 **NOISE**	1. May be normal transformer hum. 2. Overheated ballast. 3. May require special low-noise ballast. 4. Ballast transformer loose.
 **EARLY BLACKENING**	1. If ends of lamp remain lighted, short-circuited condenser or starter-switch contacts welded together. 2. If prolonged flashing or off-on blink at each start, defective starter. 3. Voltage too high.*
 **SHORT LAMP LIFE**	1. Too many lamp starts per burning hour. 2. Below-average tube. 3. Too-high or too-low line voltage.* 4. Defective starter.
DARK STREAKS ALONG TUBE	Grayish feathers are mercury usually seen on lower or cooler parts of bulb. Try rotating lamp to evaporate.
 **DENSE BLACK SPOT NEAR END**	1. Sometimes signals near end of tube life. 2. Occurring early indicates excessive current.* 3. May be bad tube.
 **GRAY RINGS**	Fairly common condition that may occur about 2" from one or both ends. Does not affect lamp operation.

Illustrations courtesy Champion Lamp Works.

*Ballast at fault

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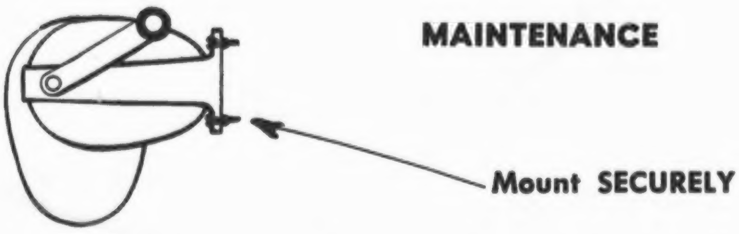
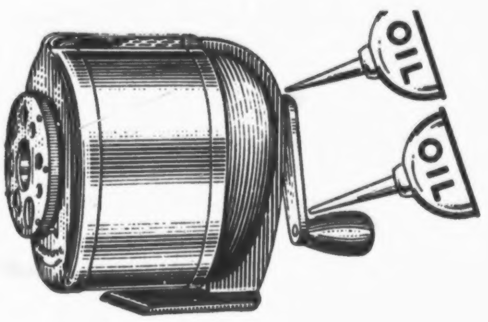
MAINTENANCE

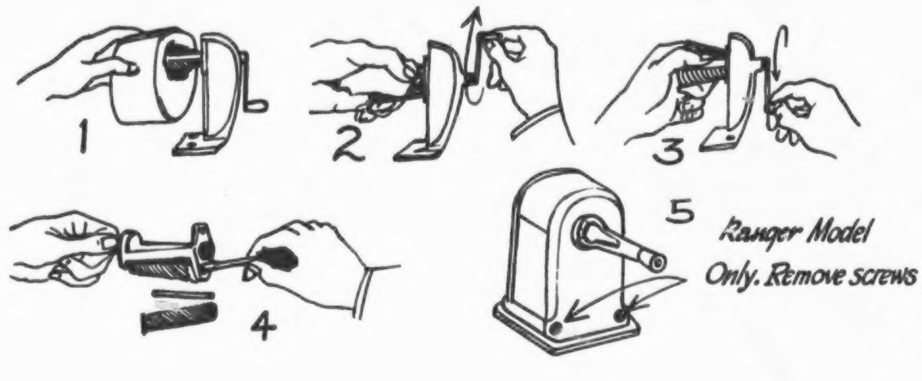


Some tips on mounting sharpeners

A little forethought in selecting a location for a mounted sharpener will pay off later. Instead of settling on "the easiest place to screw it down," or putting the sharpener in the back room, try to see that a pencil sharpener is placed:

- **where the handle will not be brushed by the elbows or sleeves of passers-by.**
- **where it cannot be struck by sliding file drawers or swinging doors.**
- **at a sufficient height so it cannot be bumped as chairs and other furniture pieces are moved about. Elbow height is generally best for wall mounts.**
- **where there is sufficient light to permit easy removal and replacement of the chip receptacle, proper setting of hole-size on pencil guides, easy use of self-feeders and setting of point-adjusters.**





HOW TO INSTALL NEW CUTTER CARRIER-ASSEMBLY OR NEW CUTTERS ONLY

1. Remove receptacle. **2.** Using waste paper to protect left hand, hold cutter carrier frame while turning handle in reverse. This will unscrew handle from threaded end of carrier shaft. Withdraw old carrier cutter frame. **3.** Insert the new carrier cutter frame making **sure that gears mesh,** before turning. Hold firmly as shown while replacing handle. **4.** If you wish to replace cutters only, remove cutter pins, replace with new cutters and refasten with pins. Insert reassembled carrier into machine as shown in #3. **5.** Ranger double bearing model—Remove 2 screws and take off rear bearing plate as shown. This gives you complete access to Ranger cutter carrier and parts.